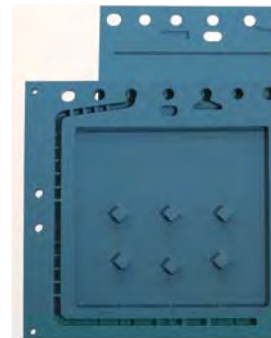
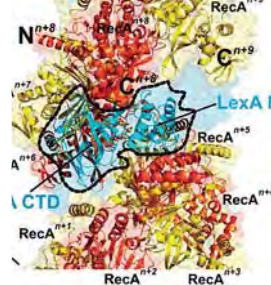


Annual Report 2013



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Ljubljana, July 2014

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INTRODUCTION



Prof. Jadran Lenarčič,
Director of the Jožef Stefan Institute

This year, like every other year, I look at the annual report of the Jožef Stefan Institute with great pleasure and pride. I am delighted by the achievements of our researchers who, in spite of the worsening conditions, achieved the highest rankings in certain fields.

Unfortunately, the socio-political climate in our country is not in favour of incorporating scientific research into economic and social development on a scale and in a form needed for Slovenia to go from “fire fighting” to planned, systematic development in all key areas.

Furthermore, development issues connected to scientific research do not become the focus of socio-political debate, even in a pre-election period. For this reason, Slovenia is not so successful at profiting from research achievements in practice and developing its economic position. It is paradoxical that the state is not giving any attention to crucial development issues. The main focus is still on even greater regulation of society, which is a counterproductive measure because it suffocates the creativity and initiative of individuals and institutions.

The result is that in Slovenia the role of scientific research is even less important and there is even greater ignorance of the processes that lead to scientific discoveries as well as the processes involved in transforming a scientific achievement, a new product, a new technology, a new creation, into something with commercial and economic value. Research is seen by the authorities as just an item in the budget that needs to be cut.

In the past two years the Jožef Stefan Institute has reacted to the cuts in government funding by increasing its income from the EU and from external partners. This is the main reason why we have managed to keep our doors open for young people. I am aware of the risks of this strategy, but it is worthy of the name of our Institute.



Prof. Jadran Lenarčič
Director of the Jožef Stefan Institute

A BRIEF HISTORY OF THE JOŽEF STEFAN INSTITUTE

1946

~ Decision taken by the Slovenian Academy of Science and Arts to build a Physics Institute

1949

~ Research connected to the peaceful use of atomic energy started, financed by the Federal Government

1952

~ Institute renamed the Jožef Stefan Physics Institute and moved to new laboratories on its present site

1954

~ The betatron and an electron microscope installed as the institute's first major pieces of equipment

1956

~ Van de Graaff accelerator, constructed at the institute, started operation

1958

~ Institute reorganised and new fields of activity defined: nuclear physics, solid-state physics, chemistry, and radiobiology

1959

~ Institute renamed the Jožef Stefan Nuclear Institute. The major source of income was provided by the Yugoslav Atomic Energy Commission



Mass spectrometer at the JSI (about 1960)

1962

~ One of the first compounds of a noble gas, XeF_6 , synthesised at the institute
~ The first computer for research, ZUSE Z 23, installed

1966

~ Nuclear research reactor TRIGA starts operation

1968

~ Yugoslav Atomic Energy Commission ceases to operate; The Republic of Slovenia becomes the institute's dominant source of research funding

1969

~ Institute is renamed as the Jožef Stefan Institute

1970

~ University of Ljubljana becomes a co-founder of the Jožef Stefan Institute, together with the Federal Executive Council

1971

~ A new unit, INOVA, established with the aim of applying the institute's expertise and output to productive use in the national economy



Institute buildings after the opening in 1953

1972

~ New computer Cyber 72 purchased, and the Republic Computer Centre established as an independent unit of the Jožef Stefan Institute

1974

~ Collaboration with the international centre CERN in the field of high-energy physics started
~ SEPO group for evaluating environmental interventions is established

1976

~ First Yugoslav 8-bit processor computer DARTA 80

1979

~ Contract defining cooperation between the Jožef Stefan Institute and the Nuclear Power Plant Krško is signed
~ First robot in Slovenia is constructed

1982

~ Ecological Laboratory with Mobile Unit established as a special unit of the Slovenian Civil Protection Organisation

1983

~ Stefin, a cysteine proteinase inhibitor named after Jožef Stefan, isolated and its primary structure determined



The Reactor Centre, Podgorica, built in 1966

1985

- ~ "2000 New Young Researchers" project established by the Slovenian Research Council
- ~ Centre for Hard Coatings established by the Jožef Stefan Institute and the firm SMELT

1987

- ~ INEA established by the Jožef Stefan Institute as an independent company to promote technology transfer in the fields of cybernetics and energy management



Nuclear magnetic resonance spectrometer

1989

- ~ Milan Čopič Nuclear Training Centre established

1990

- ~ The first Slovenian supercomputer, CONVEX, installed at the Jožef Stefan Institute

1992

- ~ New technology centres established by the Ministry of Science and Technology
- ~ Jožef Stefan Institute restructured by the Slovenian Government as a public research institution
- ~ Jožef Stefan Technology Park founded, later to become the Ljubljana Technology Park

1995

- ~ Jožef Stefan Institute is a co-founder of the international postgraduate school for environmental sciences, the Nova Gorica Polytechnic
- ~ Research institutes in Velenje, ERICo and Valdoltra established by the Institute

1997

- ~ 3.5-MeV electrostatic accelerator, TANDETRON, installed

1999

- ~ Jožef Stefan Institute celebrates its 50th anniversary

2003

- ~ Jožef Stefan International Postgraduate School established

2004

- ~ Jožef Stefan Institute is chosen as the coordinator of four Research Centres of Excellence

2007

- ~ nanomanipulation of single atoms using low-temperature scanning tunneling microscope
- ~ New ERDA/RBS beamline installed at the TANDETRON accelerator at the Microanalytical center



The beginnings of robotics at the JSI, in 1985

FORMER DIRECTORS



*Prof. Anton Peterlin,
first Director of the Jožef Stefan Institute*

Prof. Anton Peterlin, Founder and first Director of the Jožef Stefan Institute, 1949–1955

Karol Kajfež, 1955–1958

Lucijan Šinkovec, B. Sc., 1959–1963

Prof. Milan Osredkar, 1963–1975

Prof. Boris Frlec, 1975–1984

Prof. Tomaž Kalin, 1984–1992

Prof. Danilo Zavrtnik, 1992–1996

Prof. Vito Turk, 1996–2005

ORGANISATION OF THE JOŽEF STEFAN INSTITUTE

BOARD OF GOVERNORS

DIRECTOR

SCIENTIFIC COUNCIL

RESEARCH DEPARTMENTS

Physics

Theoretical Physics (F-1)

Prof. Sijetlana Fajfer

Low and Medium Energy Physics (F-2)

Asst. Prof. Primož Pelicon

Thin Films and Surfaces (F-3)

Dr. Peter Panjan, Asst. Prof. Miha Čekada

Surface Engineering and Optoelectronics (F-4)

Prof. Miran Mozetič

Solid State Physics (F-5)

Prof. Igor Muševič

Complex Matter (F-7)

Prof. Dragan Dragoljub Mihailović

Reactor Physics (F-8)

Asst. Prof. Andrej Trkov

Experimental Particle Physics (F-9)

Prof. Marko Mikuž

Chemistry and Biochemistry

Inorganic Chemistry and Technology (K-1)

Asst. Prof. Gašper Tavčar

Physical and Organic Chemistry (K-3)

Prof. Ingrid Milošev

Electronic Ceramics (K-5)

Prof. Barbara Malič

Engineering Ceramics (K-6)

Prof. Tomaž Kosmač

Nanostructured Materials (K-7)

Prof. Spomenka Kobe

Synthesis of Materials (K-8)

Prof. Darko Makovec

Advanced Materials (K-9)

Prof. Danilo Suvorov

Biochemistry, Molecular and Structural Biology (B-1)

Prof. Boris Turk

Molecular and Biomedical Sciences (B-2)

Prof. Igor Križaj

Biotechnology (B-3)

Prof. Janko Kos

Environmental Sciences (O-2)

Prof. Milena Horvat

Electronics and Information Technology

Automation, Biocybernetics and Robotics (E-1)

Asst. Prof. Leon Žlajpah

Systems and Control (E-2)

Dr. Vladimir Jovan

Artificial Intelligence Laboratory (E-3)

Prof. Dunja Mladenič

Open Systems and Networks (E-5)

Prof. Borka Jerman Blažič

Communication Systems (E-6)

Asst. Prof. Mihael Mohorčič

Computer Systems Department (E-7)

Prof. Franc Novak

Knowledge Technologies (E-8)

Prof. Nada Lavrač

Intelligent Systems (E-9)

Prof. Matjaž Gams

Reactor Techniques and Energetics

Reactor Engineering (R-4)

Prof. Leon Cizelj

CENTRES

Reactor Centre (RIC)
Prof. Borut Smodiš

Networking Infrastructure Centre (NIC)
Vladimir Alkalaj, M. Sc.

Science Information Centre (SIC)
Dr. Luka Šušteršič

Energy Efficiency Centre (EEC)
Stane Merše, M. Sc.

Centre for Knowledge Transfer in Information Technologies (CT-3)
Milja Jermol, M. Sc.

Milan Čopič Nuclear Training Centre (ICJT)
Prof. Igor Jenčič

Centre for Electron Microscopy (CEM)
Prof. Miran Čeh

Centre for Technology Transfer and Innovation (CTT)
Dr. Špela Stres

Microanalytical Instrumental Centre (MIC)
Asst. Prof. Primož Pelicon

Combined Atomic Microscope (UHV-AFM/STM)
Prof. Maja Remškar

Helium Liquifier with Superconducting Magnet and Helium Regeneration System
Milan Rožmarin, B. Sc.

Mass Spectrometry Centre
Dr. Dušan Žigon

National Centre for Microstructure and Surface Analysis
Prof. Miran Čeh

National Centre for High Resolution NMR Spectroscopy
Prof. Janez Dolinšek

Centre for Protein Structure
Prof. Dušan Turk

Nanolitography and Nanoscopy
Prof. Dragan Dragoljub Mihailović

Centre for Experimental Particle Physics in International Laboratories
Prof. Marko Mikuž

Hot Cells Facility
Prof. Borut Smodiš

Video-conferencing Centre
Prof. Borka Jerman Blažič

ADMINISTRATION, SERVICES AND SUPPORT UNITS

Administration and Services

Legal and Personnel (U-2)
Katja Novak, LL. B.

Sales and Purchase Department (U-3)
Darko Korbar, M. Sc., MBA

Finance and Accounting (U-4)
Regina Gruden, B. Econ.

Public Relations
Polona Strnad, B. Sc.

Technical Services (TS)
Aleš Cesar, B. Sc.

Support Units

Radiation Protection Unit (SVPIS)
Matjaž Stepišnik, M. Sc.

Quality Assurance (QA)
Ljubo Fabjan, M. Sc.

Centre for Business Applications (CPO)
Mato Nowak, B. Sc.

Workshops
Franc Setnikar, B. Sc.

PARTICIPATION IN THE REGIONAL DEVELOPMENT OF RESEARCH

Technology Centres

Ljubljana Technology Park Ltd.	Technology Centre for Circuits, Components, Materials, Technologies and Equipment for Electrotechnic (TC SEMTO)	Technology Centre for Production Automation, Robotics and Informatics (ARI)
University of Nova Gorica	Nanotesla Institute Ljubljana	Security Technology Competence Centre (SETTCE)
Jožef Stefan International Postgraduate School	Development Centre for Hydrogen Technologies	

Centres of Excellence

Nanocenter - Center of Excellence in Nanoscience and Nanotechnology	Centre of Excellence NAMASTE	CEBIC Centre of Excellence for Biosensors, Instrumentation and Process Control
Centre of Excellence for Integrated Approaches in Chemistry and Biology of Proteins (CIPKeBiP)	Centre of Excellence for Polymer Materials and Technologies (PoliMaT)	CO NOT: Centre of Excellence for Low-Carbon Technologies
	EN-FIST Centre of Excellence	Centre of Excellence for Space Sciences and Technologies SPACE-SI

MANAGEMENT

DIRECTORATE

Director JSI

Prof. Jadran Lenarčič

Advisers

Jože Kašman, B. Sc.

Dr. Boris Pukl

Marta Slokan, LL. B.

BOARD OF GOVERNORS

Prof. Damjan Zazula, *Chair, Ministry of Education, Science and Sport*

Alenka Avberšek, *Ministry of Education, Science and Sport*

Franjo Bobinac, *MBA, Director of Gorenje d. d., Velenje*

Dr. Tomaž Boh, *Ministry of Education, Science and Sport*

Tatjana Fink, *MBA, Director of Trimco d. d., Trebnje*

Prof. Marko Mikuž, *JSI*

Peter Ribarič, *M.Sc., Ministry for Economic Development and Technology*

Prof. Franc Solina, *Ministry of Education, Science and Sport*

Prof. Stanko Strmčnik, *JSI*

SCIENTIFIC COUNCIL

until 15 May 2013

Prof. Dragan Dragoljub Mihailovič, *President*

Prof. Denis Arčon

Prof. Leon Cizelj

Prof. Milena Horvat

Prof. Spomenka Kobe

Prof. Borka Džonova Jerman Blažič

Prof. Jadran Lenarčič

Prof. Andrej Likar

Prof. Marko Mikuž

Prof. Ingrid Milošev, *Deputy President*

Asst. Prof. Mihael Mohorčič, *Deputy President*

Prof. Peter Prelovšek

Prof. Danilo Suvorov

Prof. Vito Turk

Asst. Prof. Leon Žlajpah

since 16 May 2013

Prof. Dragan Dragoljub Mihailovič, *President*

Prof. Denis Arčon

Prof. Leon Cizelj

Prof. Miran Čeh

Prof. Borka Džonova Jerman Blažič

Prof. Milena Horvat

Prof. Spomenka Kobe

Prof. Jadran Lenarčič

Prof. Marko Mikuž

Prof. Ingrid Milošev, *Deputy President*

Asst. Prof. Dunja Mladenič

Prof. Peter Prelovšek

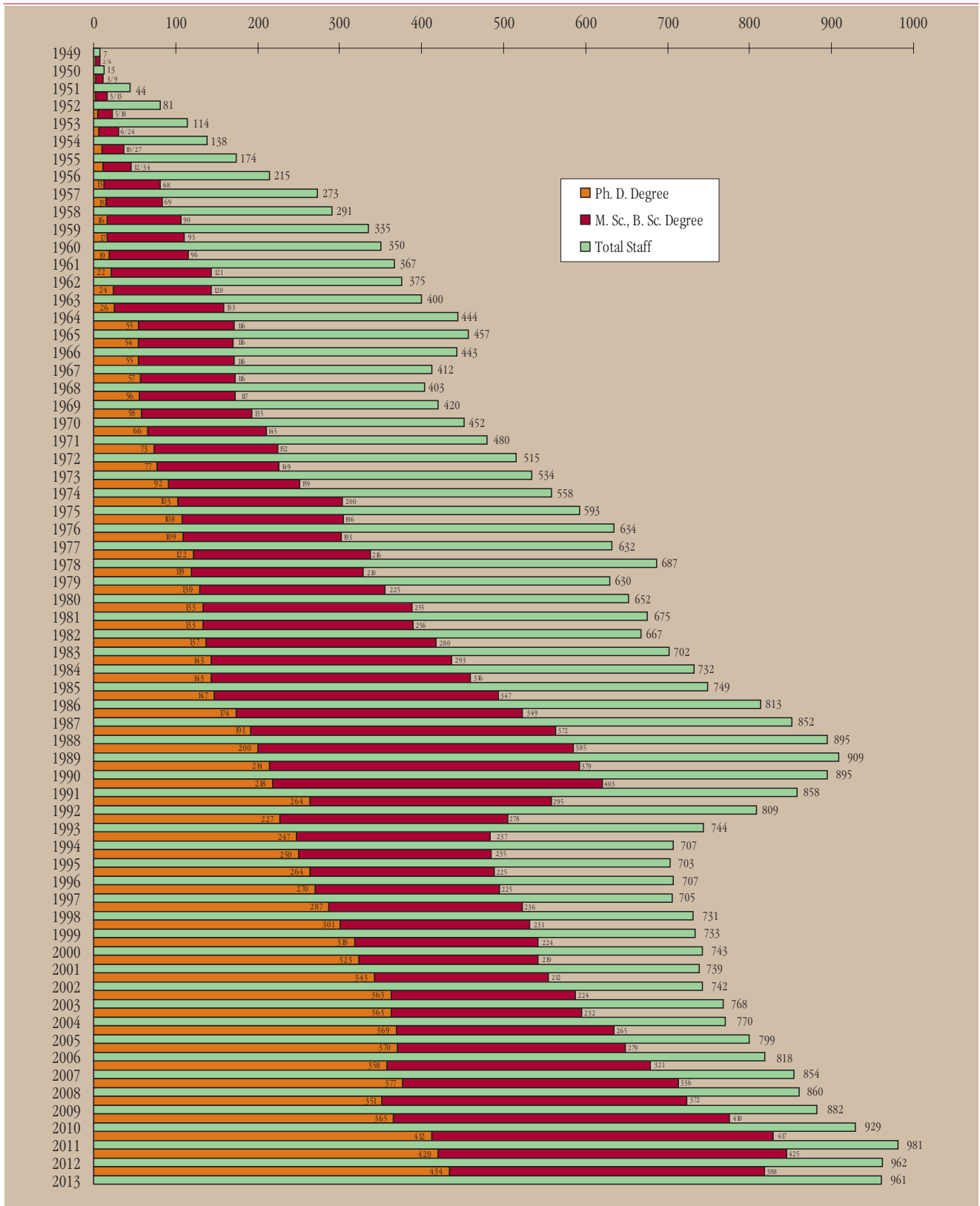
Prof. Žiga Šmit

Prof. Vito Turk

Asst. Prof. Leon Žlajpah, *Deputy President*

STAFF QUALIFICATIONS

1949-2013



RECIPIENTS OF THE JSI AWARDS AND TITLES

HONORARY MEMBERS

- Prof. Robert Blinc[☞], President of the Scientific Council of the Jožef Stefan Institute from 1992 to 2007 (1933 - 2011)
- Prof. Jean-Marie Dubois, Institut Jean Lamour, CNRS - Centre National de la Recherche Scientifique, Paris and Université Lorraine, Nancy, France
- Prof. Boris Frlc, Director of the Jožef Stefan Institute from 1975 to 1984
- Prof. Robert Huber, Nobel Prize Winner, Max-Planck-Institut für Biochemie, Munich, Germany
- Prof. Milan Osredkar[☞], Director of the Jožef Stefan Institute from 1963 to 1975 (1919 - 2003)
- Prof. Anton Peterlin[☞], Founder and First Director of the Jožef Stefan Institute from 1949 to 1955 (1908 - 1993)

ASSOCIATE MEMBERS

- Prof. David C. Ailion, University of Utah, Salt Lake City, Utah, USA
- Prof. Neil Bartlett[☞], University of California, Berkeley, California, USA
- Prof. John H. Beynon, University of Wales Swansea, Swansea, United Kingdom
- Prof. Wolfram Bode, Max-Planck-Institut für Biochemie, Munich, Germany
- Prof. Oscar D. Bonner[☞], University of South Carolina, Columbia, South Carolina, USA
- Dr. Horst Borrmann, Max-Planck-Institut für chemische Physik fester Stoffe, Dresden, Germany
- Prof. Henrik Buchowsky, Politechnika Warszawska, Warszawa, Poland
- Prof. Rüdiger Dillmann, Karlsruher Institut für Technologie, Karlsruhe, Germany
- Prof. Joseph W. Doane, Liquid Crystal Institute, Kent State University, Kent, Ohio, USA
- Prof. Hans Fritz, Universität München, Munich, Germany
- Prof. Oskar Glemser[☞], Universität Göttingen, Göttingen, Germany
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- Prof. John Holloway, University of Leicester, Leicester, United Kingdom
- Prof. Rudolf Hoppe, Universität Giessen, Giessen, Germany
- Prof. Robert J. Jaeger[☞], National Institute on Disability and Rehabilitation Research, US Department of Education, Washington, D. C., USA
- Prof. Nikola Kallay, University of Zagreb, Zagreb, Croatia
- Prof. Nobuhiko Katunuma, Tokushima Bunri University, Tokushima, Japan
- Prof. Raymond Kind, ETH, Zurich, Switzerland
- Prof. Jože Koller, National Institute of Chemistry, Ljubljana, Slovenia
- Prof. Rüdiger Mews, Universität Bremen, Bremen, Germany
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- Dr. Fani Milia, National Centre for Scientific Research "Demokritos", Athens, Greece
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- Prof. Vincenzo Parenti - Castelli, University of Bologna, Bologna, Italy

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- Prof. John A. Rupley, The University of Arizona, Tucson, Arizona, USA
- Prof. Findlay E. Russell, The University of Arizona, Tucson, Arizona, USA
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- Dr. Alain Tressaud, Institut de Chimie de la Matière Condensée de Bordeaux, CNRS, Pessac, France
- Prof. Vlado Valković, Zagreb, Croatia
- Prof. John Waugh, M.I.T., Cambridge, Massachusetts, USA

EMERITUS SCIENTISTS

- Prof. France Bremšak[☞]
- Prof. Peter Gosar
- Prof. Darko Jamnik
- Prof. Gabrijel Kernel
- Prof. Borut Mavko
- Prof. Miodrag V. Mihailović
- Prof. Raša Matija Pirc
- Prof. Marjan Senegačnik[☞]
- Prof. Boris Žemva

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Prof. Karl A. Müller, *Nobel Prize Winner*, Universität Zürich, Zurich, Switzerland

Prof. Ernst Günther Afting, GSF, Neuherberg, Germany

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Prof. John H. Beynon, University of Wales Swansea, Swansea, United Kingdom

Prof. Richard Brook, EPSRC, Swindon, United Kingdom

Prof. Julio Celis, Aarhus University, Aarhus, Denmark

Prof. Brian Clark, Aarhus University, Aarhus, Denmark

Prof. Børge Diderichsen, Novo Nordisk, Bagsvaerd, Denmark

Prof. Jean Etourneau, Institut de Chimie de la Matière Condensée de Bordeaux,
CNRS, Pessac, France

Prof. Reinosuke Hara, Seiko Instruments, Tokyo, Japan

Prof. Oleg Jardetzky, Stanford University, Stanford, California, USA

Prof. Sergey P. Kapitza, Russian Academy of Sciences, Moscow, Russia

Prof. Karl-Hans Laermann, Bergische Universität, Wuppertal, Germany

Prof. Egon Matijević, Clarkson University, Potsdam, New York, USA

Prof. Federico Mayor, Madrid, Spain

Prof. Dietrich Munz, Universität Karlsruhe, Karlsruhe, Germany

Prof. Günther Petzow, Max-Planck-Institut für Metallforschung, Stuttgart, Germany

Prof. Bernard Roth, Stanford University, Stanford, California, USA

Prof. John Ryan, University of Oxford, Oxford, United Kingdom

Prof. Volker Sörgel, Ruprecht-Karis-Universität, Heidelberg, Germany

Prof. H. Eugene Stanley, Boston University, Boston, Massachusetts, USA

Prof. Thomas Walcher, Universität Mainz, Mainz, Germany

INTERNATIONAL COOPERATION

Multilateral international cooperation	No. of projects
7. FP (COOPERATION: HEALTH, FOOD, AGRICULTURE/FISHERIES, BIOTECHNOLOGY, INFORMATION COMMUNICATION TECHNOLOGIES, NANOSCIENCES + NANOTECHNOLOGIES, MATERIALS + NEW PRODUCTION TECHNOLOGIES, ENERGY, ENVIRONMENT AND CLIMATE CHANGE, TRANSPORT (INCLUDING AERONAUTICS), SOCIO-ECONOMIC SCIENCES + THE HUMANITIES, SPACE, SECURITY; IDEAS: FRONTIER RESEARCH (EUROPEAN RESEARCH COUNCIL); PEOPLE: MARIE CURIE FELLOWSHIPS; CAPACITIES: RESEARCH INFRASTRUCTURES, SMES, REGIONS OF KNOWLEDGE, RESEARCH POTENTIAL, SCIENCE AND SOCIETY, INCO (HORIZONTAL), DEVELOPMENT OF POLICIES)	117
7. FP - EURATOM	35
ESRR	16
OTHERS (COST, IAEA, EIE, IRMM, ESA, NATO, CIP, CE, SEE, EMRP, WHO, LIFE+, ARTEMIS ...)	178
TOTAL	346

Bilateral cooperation	No. of projects
Argentina	3
Belgium	1
Brazil	1
China	5
Montenegro	3
Cyprus	1
France	19
Croatia	7
Italy	2

Bilateral cooperation	No. of projects
Japan	7
Korea	1
Macedonia	1
Romania	4
Russia	2
Serbia	5
Turkey	1
Ukraine	4
USA	18
TOTAL	85

INTERNATIONAL COOPERATION AGREEMENTS

In 2013, cooperation agreements were signed between the Jožef Stefan Institute and:

- Los Alamos National Laboratory (LANL), Los Alamos; Sandia National Laboratories (SNL), USA (F1)
- Stichting INCAS, Assen, The Netherlands (F2)
- Harder Dital Sova a.d., Niš, Serbia (F4)
- Institute of Electronic Materials Technology, Warsaw, Poland (F5)
- Kimberly-Clark Europe Limited, Surrey, Great Britain (F5)
- Westinghouse Electric Sweden AB, Vasteras, Sweden; Westinghouse Electric Company LLC, Pennsylvania, USA (F8)
- The United Kingdom Atomic Energy Authority (CCFE) of Culham Science Centre, Abingdon, Oxfordshire, United Kingdom, (F8)
- Los Alamos National Security, LLC, Los Alamos National Laboratory, Technology Transfer Division, Los Alamos, NM, USA (F8)
- The Centre National de la Recherche Scientifique, Paris, France (B2)
- VIB vzw, Zwijnaarde, Belgium (B2)
- University of Milan, Milan, Italy (B2)
- Institute of Metrology of Bosnia and Herzegovina, Sarajevo, Bosnia and Herzegovina (O2)
- Al-Farabi Kazakh National University, Almaty, Kazakhstan (O2)
- State Ecological Academy of Postgraduate Education and Management, Kiev, Ukraine (O2)
- The Foundation INCAS3, Assen, The Netherlands (E6, E9)
- GainSpan Corporation, San Jose, CA, USA (E7)
- Johannes Gutenberg University Mainz, Mainz, Germany (RIC)
- Knowledge 4 All Foundation Ltd., London, United Kingdom (CT3)
- Fish & Richardson P. C., Minneapolis, Minnesota, USA (CTT)
- Bastille LLC, Memphis, TN, USA (CTT)
- Goodyear S.A., Colmar-Berg, Luxembourg (CTT)

COOPERATION WITH UNIVERSITIES

FULL-TIME FACULTY MEMBERS

Professors

1. Asst. Prof. Denis Arčon, University of Ljubljana, Faculty of Mathematics and Physics
2. Prof. Iztok Arčon, University of Nova Gorica
3. Prof. Janez Bonča, University of Ljubljana, Faculty of Mathematics and Physics
4. Prof. Ivan Bratko, Academician, University of Ljubljana, Faculty of Computer and Information Science
5. Prof. Milan Brumen, University of Maribor, Faculty of Education
6. Prof. Dean Cvetko, University of Ljubljana, Faculty of Mathematics and Physics
7. Prof. Mojca Čepič, University of Ljubljana, Faculty of Education
8. Prof. Martin Čopič, University of Ljubljana, Faculty of Mathematics and Physics
9. Prof. Janez Dolinšek, University of Ljubljana, Faculty of Mathematics and Physics
10. Prof. Irena Drevenšek Olenik, University of Ljubljana, Faculty of Mathematics and Physics
11. Prof. Svjetlana Fajfer, University of Ljubljana, Faculty of Mathematics and Physics
12. Prof. Bojan Golli, University of Ljubljana, Faculty of Education
13. Prof. Boštjan Golob, University of Ljubljana, Faculty of Mathematics and Physics
14. Prof. Tomaž Gyergyek, University of Ljubljana, Faculty of Electrical Engineering
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50. Prof. Slobodan Žumer, University of Ljubljana, Faculty of Mathematics and Physics

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4. Dr. Tomaž Rejec, University of Ljubljana, Faculty of Mathematics and Physics

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120. Asst. Prof. Martin Žnidaršič, Faculty of Information Studies, Novo Mesto

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21. Dr. Rok Pestotnik, University of Ljubljana, Faculty of Mathematics and Physics
22. Dr. Vid Podpečan, University of Ljubljana, Faculty of Mathematics and Physics
23. Vladimir Radulović, University of Nova Gorica, School of Applied Sciences
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26. Dr. Igor Sega, University of Ljubljana, Faculty of Mathematics and Physics
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38. Žerovnik Gašper, University of Maribor, Faculty of Energy Technology
39. Dr. Dušan Žigon, Jožef Stefan International Postgraduate School, Ljubljana

DELEGATIONS AND VISITORS

Members of the National Assembly of the Republic of Slovenia, 17 January 2013

Ms Alenka Bratušek, Prime Minister of the Republic of Slovenia 17 April 2013

Ms Sunita Williams, Astronaut, 20 May 2013

Delegation of Kimberly-Clark Corporation, 22 April 2013

Delegation of Filc, d. d., Škofja Loka, 17 June 2013

Prof. Hiroshi Ishiguro, Hiroshi Ishiguro Laboratories, ATR, Japan, 11 October 2013

Delegation of Yaskawe, Japan, 12 November 2013

Delegation of UNIDO-ICPE, 18 November 2013

Delegation of National Center for Scientific Research (Centre National de la Recherche Scientifique - CNRS), France, 18 November 2013

Ms Francesca Grassia, Deputy Director of European Research Area-East

Ms Florence Noble, Deputy Scientific Director, Institute of Biological Sciences (INSB)



Sunita Williams and Prof. Jadran Lenarčič

ART EXHIBITIONS AT THE JSI

Riko Debenjak, 21 January-14 February

Borut Peterlin, 18 February-14 March

Srečo Dragan, Lujo vodopivec, Tugo Šušnik, 18 March-11 April

Zvonko Čoh, 15 April-9 May

Jože Slak-Đoka, 13 May-6 June

Barbara Demšar, 10 June-4 July

Ljubljana Fine Artists Society, 8 July-29 August

Maša Gala, 2 September-26 September

Adolf Mljač, 30 September-24 October

Sašo Vrabič, 11 November-5 December

Gregor Pratneker, 9 December- 16 January 2014



Prof. Jadran Lenarčič, Director of the JSI, and Srečo Dragan at the opening of the exhibition

INSTITUTE COLLOQUIA

16 January: **Marko Bohanec**

Jožef Stefan Institute

Qualitative multiparametric modeling and DEX method: Yesterday, today, and tomorrow

30 January: **Gregor Anderluh**

National Institute of Chemistry, Ljubljana

Biological nanopores

20 February: **Sadamichi Maekawa**

Tohoku University, Sendai, Japan

Spin-motive force as a new energy conversion mechanism

6 March: **Antonio Šiber**

Institute of Physics, Zagreb, Croatia

Some physics of viruses and the grand questions still unanswered

19 March: **Peter Suhadolc**

University of Trieste, Trieste, Italy

Achievements and challenges of modern seismology

21 March: **Janez Bonča**

University of Ljubljana and Jožef Stefan Institute

Nonequilibrium dynamics of correlated systems

22 March: **Luka Snoj**

Jožef Stefan Institute

Will we generate energy from water?

28 March: **Luiz A. DaSilva**

Trinity College, Dublin, Ireland

Orchestrating virtual wireless networks from shared resource pools

3 April: **Cristian Micheletti**

Scuola Internazionale Superiore di Studi Avanzati, Trieste, Italy

The knotted strands of life

9 April: **Luigi Colombo**

Texas Instruments Incorporated, Dallas, USA

Graphene and graphene device integration: A materials perspective

24 April: **Boštjan Zalar**

Jožef Stefan Institute

Liquid-crystalline elastomers: In search of morphing plastics

8 May: **Juergen Kurths**

Potsdam Institute for Climate Impact Research and Humboldt University Berlin, Berlin, Germany, and University of Aberdeen, Aberdeen, Great Britain

Synchronization in dynamical systems and complex networks and its applications

22 May: **Maja Čemažar**

Institute of Oncology, Ljubljana

Application of electroporation in medicine: Electrochemotherapy and electrogene therapy

5 June: **Hrvoje Buljan**

University of Zagreb, Zagreb, Croatia

Ultracold atomic gases as quantum abacus beads

28 August: **Milovan Šuvakov**

Institute of Physics, Belgrade, Serbia

The Newtonian three-body problem: 13 new periodic solutions and topological classification

13 September: **Grzegorz Wrochna**

National Centre for Nuclear Research at Swierk, Otwock-Swierk, Poland

Nuclear power today and tomorrow

17 September: **Yosef Nir**

Weizmann Institute of Science, Rehovot, Israel

Flavor physics: past, present, future

11 October: **Hiroshi Ishiguro**

Osaka University, Osaka and Advanced Telecommunications Research Institute International, Kyoto, Japan

Robots, humans, and media

27 November: **Miran Čeh**

Jožef Stefan Institute

Scanning transmission electron microscopy: Applications in materials science

4 December: **Slobodan Žumer**

University of Ljubljana, Jožef Stefan Institute, and NAMASTE Center of Excellence

Topological soft matter

11 December: **Saša Novak Krmpotič**

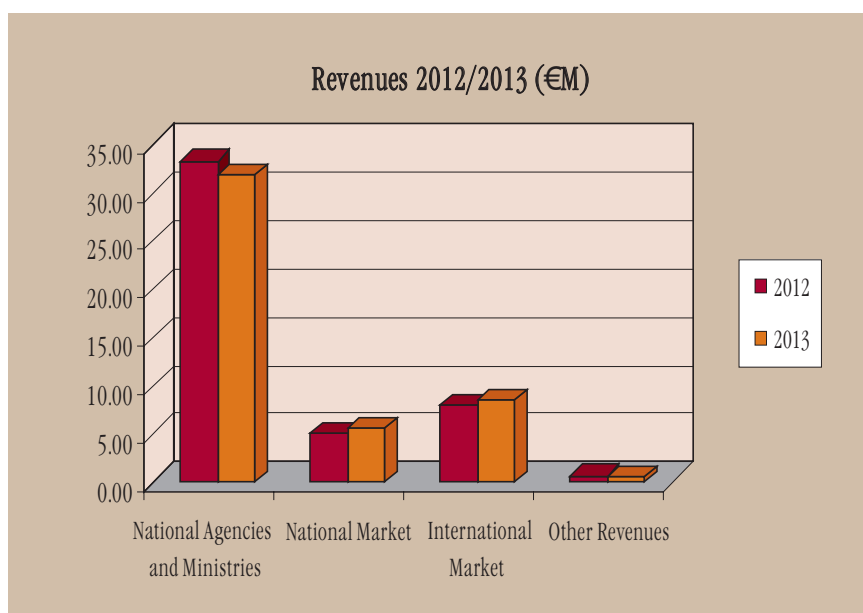
Jožef Stefan Institute

Materials for bone replacement and regeneration

FINANCING

REVENUES JSI (€) AND NUMBER OF PROJECTS

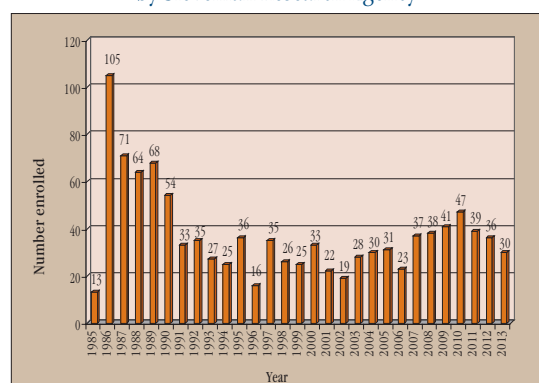
	Contribution		Contribution			No. of Projects in 2013
	2013	2013	2012	2012	Index 2013/2012	
National Agencies and Ministries	31,811,691	68.5 %	33,267,535	71.1 %	95.5	464
National Market	5,598,584	12.0 %	5,012,171	10.7 %	111.7	193
International Market	8,526,897	18.4 %	7,924,955	16.9 %	107.6	326
Other Revenues	526,217	1.1 %	585,646	1.3 %	95.5	
TOTAL	46,463,389	100.0 %	46,790,307	100.0 %	99.3	983



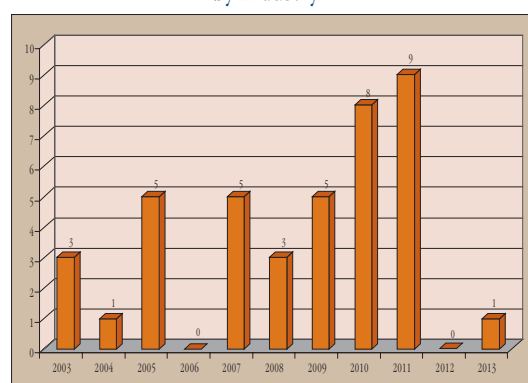
POSTGRADUATES FINANCED

1985-2013

by Slovenian Research Agency



by Industry



JSI UNDERGRADUATE SCHOLARSHIPS

1977-2013

Year	FMF		FKKT UNI LJ	FKKT UNI MB	NTF	FDV	FA	BF	FE and FRI	Other UNI LJ	FG and FERI	UNG	IPS	Total
	Physics	Mathematics												
... 1982	115	38	100						50	12				315
1983	10	1	5						9		1			26
1984	11	3	7					1	12		1			35
1985	18	4	6					1	19		1			49
1986	16	8	4						22	2				52
1987	20	8	4						23	2				57
1988	26	7	8					1	27	2				71
1989	26	6	10					1	19	3	1			66
1990	26	5	11					2	25		1			70
1991	23	2	9					2	24	2	1			63
1992	22	3	16					3	17	1				62
1993	21	1	15					3	13	1				54
1994	7	1	8					3	6					25
1995	2		9					3	5					19
1996	2		9					3	5					19
1997	2		12					1	4		1			20
1998	1		6					1	7		1			16
1999	2		7					4	7					20
2000	1		5					3	9					18
2001	3		13					3	10					29
2002	4		20					3	10					37
2003	3		18					2	12	1				36
2004	4		17					1	15	1	2	2		42
2005	3		12			1		2	19		2	1		40
2006	2		12			1		1	17		2	2		37
2007	3		14			1		2	18		2	1		41
2008	2	1	13	3		1		2	15		1	1		39
2009	2	1	17	4		1		5	16		1	2		49
2010	2		11	5	2	1	1	3	10		1	2	5	43
2011	2	1	11	5	4	1	1	4	7		1		6	43
2012	2		10	6	3	1		3	6				5	36
2013	3	2	3	2	1		1		2	2			6	22
TOTAL	386	92	422	25	10	8	3	63	460	29	20	11	22	1551

FMF Faculty of Mathematics and Physics, University of Ljubljana
FKKT (Uni-Lj) Faculty of Chemistry and Chemical Technology, University of Ljubljana
FKKT (Uni-Mb) Faculty of Chemistry and Chemical Technology, University of Maribor
NTF Faculty of Natural Sciences and Engineering, University of Ljubljana
FDV Faculty of Social Sciences, University of Ljubljana
FA Faculty of Administration, University of Ljubljana
BF Biotechnical Faculty, University of Ljubljana

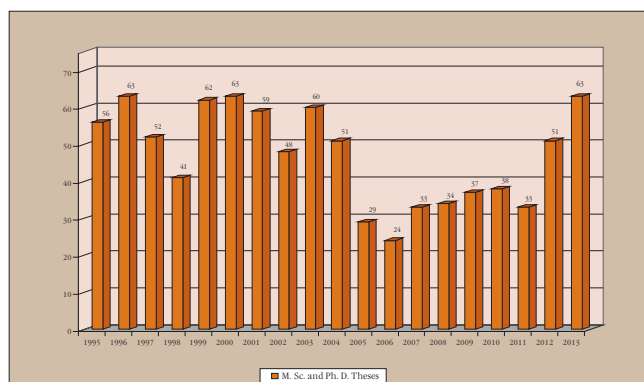
FE Faculty of Electrical Engineering, University of Ljubljana
FRI Faculty of Computer and Information Science, University of Ljubljana
FG Faculty of Civil Engineering, University of Maribor
FERI Faculty of Electrical Engineering and Computer Science, University of Maribor
UNG University of Nova Gorica
IPS Jožef Stefan International Postgraduate School
Other UNI LJ Faculty of Pharmacy, Faculty of Mechanical Engineering, Faculty of Economics, Faculty of Medicine, University of Ljubljana

COMPLETED THESES

UNTIL 2013

Year	Ph. D. Theses	M. Sc. Theses	Total
...1962	15	6	21
1963	7		7
1964	7	2	9
1965	16		16
1966	2		2
1967		8	8
1968	4	8	12
1969	3	6	9
1970	2	12	14
1971	7	6	13
1972	11	24	35
1973	8	14	22
1974	21	10	31
1975	10	20	30
1976	6	31	37
1977	5	16	21
1978	10	20	30
1979	7	11	18
1980	13	10	23
1981	12	15	27
1982	13	18	31
1983	5	10	15
1984	14	17	31
1985	6	14	20
1986	8	15	23
1987	18	21	39

Year	Ph. D. Theses	M. Sc. Theses	Total
1988	12	26	38
1989	15	33	48
1990	16	41	57
1991	22	47	69
1992	19	42	61
1993	28	36	64
1994	27	37	64
1995	34	22	56
1996	38	25	63
1997	29	23	52
1998	21	20	41
1999	33	29	62
2000	36	27	63
2001	31	28	59
2002	29	19	48
2003	41	19	60
2004	31	20	51
2005	22	7	29
2006	22	2	24
2007	26	7	33
2008	29	5	34
2009	30	7	37
2010	33	5	38
2011	31	2	33
2012	47	4	51
2013	56	7	63
TOTAL	988	854	1842



PATENTS GRANTED

1. S. G. Psakhie, Volia Isaevich Itin, D. A. Magajeva, O. G. Terehova, E. P. Najden, Olga Vasiljeva, Georgij Mihajlov Andrejevič, Urška Mikac, Boris Turk
Contrast agent for T1 and/or T2 magnetic resonant scanning and method for preparing it
Patent No. RU2471502 (C1), Federal Service for Intellectual Property, 10.1.2013.
1. Bojan Likar, Robert Posel, Andreas Kalagasidis, Tomaž Javornik, Gorazd Kandus, Janez Sterle, Urban Sedlar, Janez Bešter, Andrej Kos, Luka Mali
Method for self organizing network operation
Patent No. US8472334 (B2), US Patent Office, 25.6.2013.
2. Maja Remškar, Marko Viršek, Miha Kocmur, Adolf Jesih
Procedure for synthesis of threadlike tungsten oxide W5O14
Patent No. US8496907 (B2), US Patent Office, 30.7.2013.
3. Luca Gregoratti, Marco Peloi, Marija Kosec, Danjela Kuščer, Giuseppina Palma
A material in the form of lithium fluoride powder containing colour centres, method for preparation and use thereof
Patent No. US8535434 (B2), US Patent Office, 17.9.2013.
4. Janez Pirš, Matej Bažec, Silvija Pirš, Bojaan Marin, Bernarda Urankar, Dušan Ponikvar
Variable contrast, wide viewing angle LCD light-switching filter
Patent No. US8542334 (B2), US Patent Office, 24.9.2013.
5. Bojan Likar, Robert Posel, Andreas Kalagasidis, Tomaž Javornik, Gorazd Kandus, Mihael Mohorčič, Aleš Švigelj, Janez Bešter, Andrej Kos, Miha Smolnikar
Iterative localization techniques
Patent No. US8565106 (B2), US Patent Office, 22.10.2013.
6. Ida Istinič, Meti Buh Gašparič, Jerica Sabotič, Kristina Gruden, Jože Brzin, Jana Žel
Use of macrocypines as pesticidal agents
Patent No. SI23835 (A), Slovenian Intellectual Property Office of Russia, 28.2.2013.
7. Matjaž Gams, Rok Piltaver, Erik Dovgan, Andrej Planina, Gašper Pintarič, Bogdan Pogorelc
Intelligent surveillance system and procedure for detection of unusual behaviour
Patent No. SI23855 (A), Slovenian Intellectual Property Office, 28.2.2013.
8. Borut Štrukelj, Samo Kreft, Damjan Janeš, Nina Kočevnar Glavač, Eva Tavčar, Marko Slokar, Ante Zaloker, Viktor Grilc, Ivan Mirt, Željko Cerovečki
Complex antioxidant extract from the bark of fir tree with cyclodextrins
Patent No. SI23862 (A), Slovenian Intellectual Property Office, 29.3.2013.
9. Borut Štrukelj, Samo Kreft, Damjan Janeš, Nina Kočevnar Glavač, Eva Tavčar, Marko Slokar, Ante Zaloker
Refined liquid antioxidant extract from the bark of fir tree and process for its production
Patent No. SI23867 (A), Slovenian Intellectual Property Office, 29.3.2013.
10. Silvan Bucik, Borut Baričevič, Borut Repič, Matjaž Vencelj
A method of analog and digital signal processing of information contained in pulses, and a device for achieving the same.
Patent No. SI23959 (A), Slovenian Intellectual Property Office, 28.6.2013.
11. Andrej Kovič, Adolf Jesih, Aleš Mrzel
The procedure for the synthesis of 4d and 5d (Nb, Mo Ta, W) nitrites of transition metals in the form of quasi-one-dimensional structures
Patent No. SI23988 (A), Slovenian Intellectual Property Office, 30.8.2013.
12. Kostja Makarovič, Janez Holc, Darko Belavič, Marko Hrovat, Marija Kosec
Multilayer ceramic structures for non-contact dielectric heating of liquids
Patent No. SI24008 (A), Slovenian Intellectual Property Office, 30.8.2013.
13. Primož Titan, Jernej Iskra, Vladimir Meglič
Chemical hybridization of hermaphrodite plant species with easily soluble derivatives of oxanilic acid
Patent No. SI24033 (A), Slovenian Intellectual Property Office, 30.10.2013.
14. Gregor Černe, Mitja Bizjak, Bogdan Filipič, Tea Tušar, Erik Dovgan
A system for offer selection and request formation in demand response and distributed production of electrical energy
Patent No. SI24057 (A), Slovenian Intellectual Property Office, 30.10.2013.
15. Marina Santo-Zarnik, Darko Belavič, Marjan Hodnik, Sandi Kocjan
A pressure-sensor module with a ceramic cantilever sensing structure
Patent No. SI24085 (A), Slovenian Intellectual Property Office, 29.11.2013.
16. Marija Vukomanovič, Srečo D. Škapin, Danilo Suvorov
Composites materials based on ceramic phase and metal with functionalized surface as environmentally-friendly materials with antibacterial activity, a process for preparing and use thereof
Patent No. SI24094 (A), Slovenian Intellectual Property Office, 31.12.2013.
17. Igor Kovač, Borut Lenart, Bojan Nemeč, Marko Scortegagna, Leon Žlajpah
Humanoid torso mechanism
Patent No. SI24099 (A), Slovenian Intellectual Property Office, 31.12.2013.

AWARDS AND APPOINTMENTS

AWARDS MADE TO JSI RESEARCHERS BY THE REPUBLIC OF SLOVENIA

Zois Award and Zois Certificate of Recognition

Janko Kos

Presented with the Zois Award for the highest scientific achievements in the field of proteolytic enzymes and their regulation

Nada Lavrač

Presented with the Zois Certificate of Recognition for her work in intelligent data analysis

Saša Novak Krmpotič

Presented with the Zois Certificate of Recognition in the field of materials

JSI AWARDS AND APPOINTMENTS

The Jožef Stefan Golden Emblem Prize

presented to the following for doctoral theses with high impact:

Lev Vidmar

Influence of phonons on physics of strongly correlated electron systems

Jernej Jorgačevski

Fusion pore properties of cultured rat lactotrophs

Marko Sedlaček

Influence of surface topography on tribological behavior of contact surfaces

SELECTED OTHER AWARDS TO JSI RESEARCHERS

Nemanja Aničič, Award of the Henkel Slovenia Foundation for B. Sc. Thesis, Faculty of Chemistry and Chemical Engineering, University of Maribor, Maribor, »Application of the population balance model for the prediction of concentrated emulsion droplet size distribution«.

Leon Bedrač, Krka Awards for PhD Thesis, Novo mesto, Slovenia, 2013

Marko Bohanec, Best paper reward on International Conference 26th Bled eConference - eInnovation: Challenges and Impacts for Individuals, Organizations and Society

Sandra Drev, Aleksander Rečnik, Nina Daneu, „Twinning and inclusions in chrysoberyl from Pratinhas, Brazil“, MC2013 Best poster award in Materials science at the MC2013 Microscopy Conference, Regensburg, Germany, 25 – 30 August 2013

Sašo Džeroski, Nikola Simidjievski, Ljupčo Todorovski, Best ICT paper on 5th Jožef Stefan International Postgraduate School Students Conference

Jernej Fesl Kamenik, “Svečana listina” award for exceptional scientific and educational achievements, University of Ljubljana



The winners of Zois Award and Zois Certificates of Recognition: Prof. Nada Lavrač, Prof. Janko Kos and Asst. Prof. Saša Novak Krmpotič

Matjaž Gams, Hristijan Gjoreski, Simon Kozina, Mitja Luštrek, 1st place at the international activity-recognition competition, EvAAL 2013 (Evaluating AAL Systems through Competitive Benchmarking), Norrköping, Sweden, The AAL Open Association, RAREFall

Medeja Gec, Matic Krivec, Kristina Žagar, Luka Suhadolnik, Darja Jenko, Goran Dražič, Miran Čeh, „Comparison of TEM lamella preparation techniques on titania nanotube-arrays/metal Ti interface“, MC2013 Best poster award in Instrumentation and Methods, at the MC2013 Microscopy Conference, Regensburg, Germany, 25 – 30 August 2013

Matjaž Gomilšek, Prešeren Award of the Faculty of Mathematics and Physics for Diploma thesis, University of Ljubljana, Ljubljana, Time irreversible billiards

Nadja Hvala, The article “Modelling, simulation and control of an industrial, semi-batch, emulsion-polymerization reactor” in Computers and Chemical Engineering Journal has according to Elsevier more than 500 downloads. It has been identified as one of the most downloaded articles in this journal in the period from Sept. 2012 - Aug. 2013 and has received a certificate for this contribution.

Marja Jerič, Miran Čeh, „Molten salt synthesis of Nb-doped Sr₃Ti₂O₇ platelet seeds“, The best poster among young researchers in the research field Nanomaterials and Nanotechnology, 21st Conference on Materials and Technology, Portorož, Slovenia, 13 – 15 November 2013

Nina Kostevšek, Kristina Žužek Rožman, Sašo Šturm, Spomenka Kobe, „Hybrid FePt/Au Nanoparticles With a Combined Magneto-Photothermal Effect“, The best presentation among young researchers in the research field Nanomaterials and Nanotechnology, 21st Conference on Materials and Technology, Portorož, Slovenia, 13 – 15 November 2013

Primož Koželj, Best paper award, Ljubljana, The European Integrated Center for the Development of New Metallic Alloys and Compounds, C-MAC days 2013, Ljubljana

Marjeta Kramar Fijavž, Best University Teacher Award at Department of Civil Engineering, University of Ljubljana, Faculty of Civil and Geodetic Engineering, awarded by the Student Council of the Faculty, Ljubljana, December 2013

Igor Krizaj, Adrijana Leonardi, Dušan Kordiš, Award of the Slovenian Research Agency for an exceptional scientific achievement in 2012 in Slovenia in the field of Biochemistry and Molecular Biology (Conus consors snail venom proteomics unveils functions, pathways and novel families involved in its venomous system)

Zdravko Kutnjak, Mentor awards in 2013, the Society of Young Researchers Slovenia

Sebastjan Peljhan, Maks Samec Awards for PhD Thesis in the field of Chemistry, Ljubljana, Slovenia, 2013

Vid Podpečan, The outstanding scientific achievement: Environment Orange4WS for service-oriented data mining, Applicant: Public Research Agency of the Republic of Slovenia (SRA), the Scientific Council for Engineering

Aleksandra Rashkovska, Special prize for innovations for economy at the 6th International Transfer Conference and Innovation Day 2013, Brdo pri Kranju, Smart Thermo Therapy

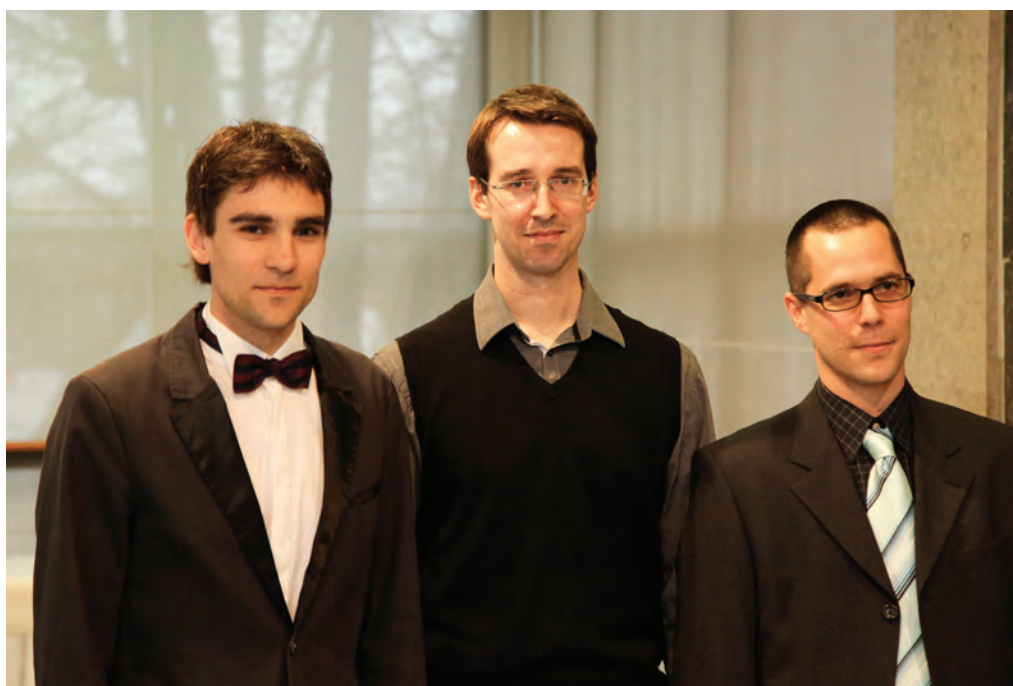
Peter Rodič, Ingrid Milošev, Jernej Iskra, Barbara Kapun, 1st prize at the 6th International Conference for technology transfer together with Innovation Day of the Chamber of Commerce of Slovenia for innovation with largest market potential after the selection of local and foreign experts in the field of technology transfer and representatives of domestic and foreign venture capital, 2013

Luca Tubiana, Best PhD Thesis in Physics Award, Trieste, Italy, SISSA-ISAS.

Alenka Vesel, Award for the most cited article in the Journal Dyes and Pigments in years 2010 and 2011. Title of the article: “Colorimetric properties of reversible thermochromic printing inks”

Tea Zuliani, Radmila Milačič, Janez Ščančar, the Poster Prize at the «2013 Winter Conference on Plasma Spectrochemistry» taking place in Krakow, Poland, 10–15 February 2013, for her presentation entitled “Cr(VI) determination in soil solution by speciated isotope dilution ICP-MS”

In 2013 United Nations and UNESCO award **Videolectures.Net portal** for best educational product of the decade. The VideoLectures.Net was selected as the winner in the “e- Science & Technology” category



The winners of the Jožef Stefan Golden Emblem Prize: Dr. Lev Vidmar, Dr. Jernej Jorgačevski and Dr. Marko Sedlaček

REVIEW OF PUBLICATIONS

FOR 2013

Department	Original Articles*	Books	Patent Appl. and Grants	Theses
Department of Theoretical Physics (F-1)	95			4
Department of Low and Medium Energy Physics (F-2)	75		2	1
Department of Thin Films and Surfaces (F-3)	22			
Department of Surface Engineering and Optoelectronics (F-4)	59			
Department of Solid State Physics (F-5)	140		4	8
Department for Complex Matter (F-7)	50		2	4
Department of Reactor Physics (F-8)	34	4		2
Department of Experimental Particle Physics (F-9)	208			3
Department of Inorganic Chemistry and Technology (K-1)	38		2	2
Department of Physical and Organic Chemistry (K-3)	27		3	3
Electronic Ceramics Department (K-5)	51		4	2
Engineering Ceramics Department (K-6)	10			1
Department for Nanostructured Materials (K-7)	66	2	1	3
Department for Synthesis of Materials (K-8)	28			1
Department for Advanced Materials (K-9)	37		2	1
Department of Biochemistry, Molecular and Structural Biology (B-1)	35		2	2
Department of Molecular and Biomedical sciences (B-2)	16			1
Department of Biotechnology (B-3)	58	2	3	
Department of Environmental Sciences (O-2)	122			7
Department of Automation, Biocybernetics and Robotics (E-1)	46		2	3
Department of Systems and Control (E-2)	67		2	
Artificial Intelligence Laboratory (E-3)	43	1		
Laboratory for Open Systems and Networks (E-5)	15			
Department of Communication Systems (E-6)	47		3	2
Computer Systems Department (E-7)	28			1
Department of Knowledge Technologies (E-8)	64			5
Department of Intelligent Systems (E-9)	64	1	4	5
Department of Reactor Engineering (R-4)	56	1		1
Reactor Infrastructure Centre (RIC)	21	3		
Networking Infrastructure Centre (NIC)	1			
Science Information Centre (SIC)	1			
Energy Efficiency Centre (EEC)	21			
Milan Čopič Nuclear Training Centre (ICJT)	4			
Radiation Protection Unit (SVPIS)	1	1		
Centre for Technology Transfer and Innovation (CTT)	2			1
Jožef Stefan Institute	1533	13	32	63

* Articles in Journals and Conference Proceedings, and Chapters in Books

KNOWLEDGE TRANSFER

The JSI pays a lot of attention to furthering its links with industry. In keeping with European aims and the objectives of the Slovenian government, the JSI organized several important meetings on the subject of cooperation with enterprises and

industry. In this way the JSI introduced a new method of cooperation, showing industry and the public that it is aware of its leading role, not only in research but also in the transfer of knowledge into practice.

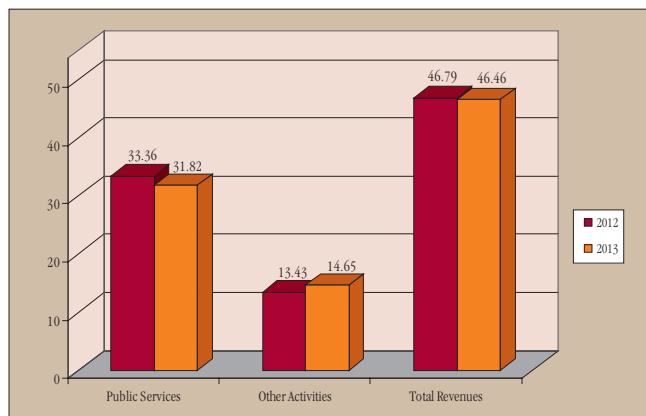
R & D PROJECT PARTNERS

1. Abak.net, d.o.o., Murska Sobota
2. Acies Bio, d.o.o., Ljubljana
3. Adria Mobil, d.o.o. Novo mesto
4. Akripol, d.o.o., Trebnje
5. Amebis, d.o.o., Kamnik
6. Ames, d.o.o., Brezovica pri Ljubljani
7. ARAO-Slovenian Agency for Radioactive Waste Management,, Ljubljana
8. Arctur, d.o.o., Nova Gorica
9. B2, d.o.o., Ljubljana
10. Balder, d.o.o., Ljubljana
11. Beyond Devices, d.o.o., Brezovica pri Ljubljani
12. BIA Separations, d.o.o., Ajdovščina
13. CDT skupina, d.o.o., Kropa
14. Central Technological Library at the University of Ljubljana, Ljubljana
15. Chemicals Office of the Republic of Slovenia, Ljubljana
16. Cosylab, d.d., Ljubljana
17. Creatim Ržišnik Perc, d.o.o., Šenčur
18. Development Centre RC eNeM, d.o.o., Ljubljana
19. Domel, d.o.o., Železniki
20. Ecological Engineering Institute, d.o.o., Maribor
21. Ekliptik, d.o.o., Ljubljana
22. Elgoline, d.o.o., Cerkljina
23. Ema, d.o.o., Celje
24. Entia, d.o.o., Ljubljana
25. Gama System, d.o.o., Ljubljana
26. Gen energija, d.o.o., Krško
27. Gorenje, d.d., Velenje
28. Inea, d.o.o., Ljubljana
29. Informa Echo, d.o.o., Ljubljana
30. Institute of Microbial Sciences and Technologies, d.o.o., Domžale
31. Intec Tiv, d.o.o., Kranj
32. Intech - Les, d.o.o., Rakek
33. JP CCN Domžale-Kamnik, d.o.o., Domžale
34. JP Vodovod-Kanalizacija, d.o.o. Ljubljana
35. Keko - Oprema, d.o.o., Žužemberk
36. Knauf Insulation, d.o.o., Škofja Loka
37. Kolektor Group, d.o.o., Idrija
38. Kolektor KFH, d.o.o., Idrija
39. Kolektor Sikom, d.o.o., Idrija
40. Kovinos, d.o.o., Horjul
41. Krško Nuclear Power Plant, Krško
42. Labena, d.o.o., Ljubljana
43. Lek, d.d., Ljubljana
44. Lotrič Metrology, d.o.o., Selca
45. Magneti Ljubljana, d.d., Ljubljana
46. MEIS storitve za okolje, d.o.o., Šmarje Sap
47. Melamin kemična tovarna d.d., Kočevje
48. Metrology Institute of the Republic of Slovenia, Celje
49. Milan Vidmar Electric Power Research Institute, Ljubljana
50. Ministry of Education, Science and Sport of the Republic of Slovenia, Ljubljana
51. Ministry of Infrastructure and Spatial Planning of the Republic of Slovenia, Ljubljana
52. Ministry of Defence of the Republic of Slovenia, Ljubljana
53. Optacore, d.o.o., Ljubljana
54. Research Centre Energy, d.o.o., Velenje
55. Result, d.o.o., Ljubljana
56. Robotina, d.o.o., Kozina
57. Slovenian Environment Agency, Ljubljana
58. Solvera Lynx, d.d., Ljubljana
59. Stelem, d.o.o. Žužemberk,
60. Strolab, d.o.o., Sežana
61. Špica International, d.o.o., Ljubljana
62. Štore Steel, d.o.o., Štore
63. Technology Park Ljubljana, d.o.o., Ljubljana
64. UCS, d.o.o., Vrhnika
65. Unior, d.d., Zreče
66. Vacutech, d.o.o., Ljubljana
67. Varsi, d.o.o., Ljubljana
68. Velenje Coal Mine, d.d., Velenje
69. Xenya, d.o.o., Ljubljana
70. Xlab, d.o.o., Ljubljana

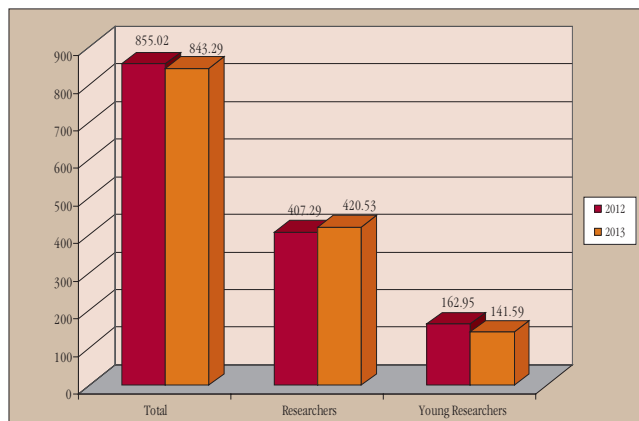
INSTITUTE IN NUMBERS

2012-2013

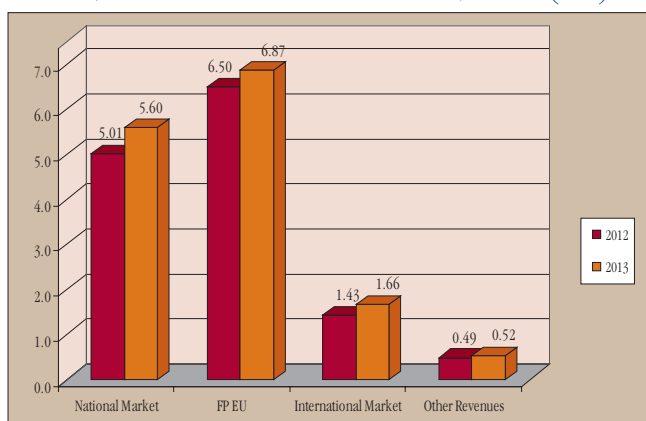
COMPARISON OF REVENUES (€M)



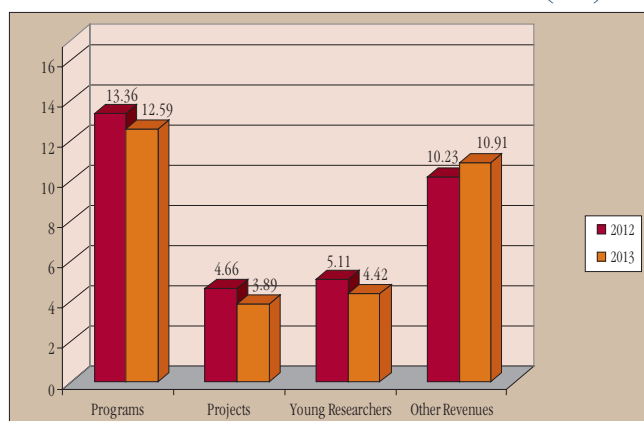
EMPLOYEES (FTE)



REVENUES FROM OTHER ACTIVITIES (€M)



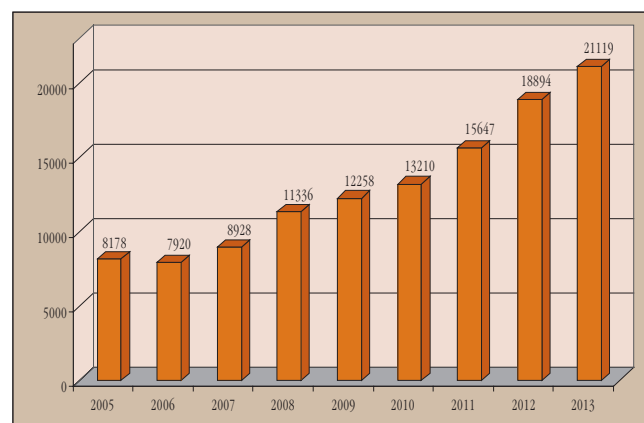
REVENUES FROM PUBLIC SERVICES (€M)



NUMBER OF PUBLICATIONS
IN THE WEB OF SCIENCE



NUMBER OF CITATIONS
IN THE WEB OF SCIENCE



RESEARCH DEPARTMENTS

DEPARTMENT OF THEORETICAL PHYSICS

F-1

The group of THEORETICAL PHYSICS OF NUCLEI, PARTICLES AND FIELDS has investigated the structure of hadrons, the effective theories of weak and electromagnetic mesonic decays, the unified theory of elementary interactions, the relativistic theory of membranes and precise calculations of the properties of three-body systems in atomic physics.

Meson scattering and electroproduction in the D13, D33 and D15 partial waves are calculated in a coupled-channel approach incorporating quasi-bound quark-model states. In contrast to our previous results in the P11, P33 and S11 partial waves, the meson and photon couplings turn out to be underestimated, but otherwise our results exhibit a consistent behaviour in all channels.

The unambiguous evidence for the interesting state X(3872) was found using an ab-initio lattice QCD simulation for the first time. This charmonium-like state is particularly interesting since it is most likely a mesonic molecule. The exciting state Zc(3900), which was experimentally discovered in the spring of 2013 and is composed of two quarks and two anti-quarks, was simulated on the lattice for the first time. We studied the meson decay widths using the extended method we proposed last year and demonstrated how it works in practice by determining the K*(892), D0*(2400) and D1(2430) strong decay widths.

In the past year we implemented a new state-of-the-art method called stochastic distillation, which allowed us to calculate correlation functions on a 3fm lattice. We used this method to study the controversial meson Ds(2317), where we confirmed experimentally observed properties and settled a long-standing issue between theory and experiment.

We performed an analysis of Higgs portal models of dark matter (DM), where DM is light enough to contribute to invisible Higgs decays. Using effective field theory we showed that DM can be a thermal relic only if there are additional light particles present with masses below a few 100 GeV. We also gave three concrete examples of viable Higgs portal models of light DM. We systematically investigated the implications of the leading dimension five operators on Higgs phenomenology in the presence of dynamical vector-like quarks. After taking into account the constraints from precision electroweak and flavour observables we showed that contrary to the renormalizable models, significant modifications of the Higgs' properties are still possible. We reconsidered the recent observation by the D0 experiment of a sizable like-sign dimuon charge asymmetry, highlighting that it could be affected by CP-violating contributions not only in Bd- and Bs-meson mixings, but also in semi-leptonic decays of b and c quarks. We also showed that such effects would be clear indications of new physics. We showed that warped extra-dimensional models that explain the quark spectrum can naturally give rise to contributions of the size required to explain the recent LHCb result for a CP violation in D meson decays. We also explained important subtleties in the calculations of certain one-loop processes within warped extra-dimensional models. We furthermore discussed the interpretation of this result within the framework of partial compositeness in four dimensions.

An explanation for the too large measured branching fraction of decays $B \rightarrow D$ tau nu in $B \rightarrow D^* \tau \nu$ has still not been provided and the result of the BaBar collaboration is still valid. We have studied a scenario with the addition of a single scalar particle that couples to quarks and leptons. We have endowed this leptoquark with the quantum number (3,2,7/6) and a minimal set of flavour coupling that suffices to explain the $B \rightarrow D^* \tau \nu$ anomaly and is consistent with constraints from other processes. These are decay $Z \rightarrow b$ anti-b, lepton flavour violating decays (e.g., $\mu \rightarrow e \gamma$), and magnetic and electric dipole moments. In the framework of a Grand



Head:
Prof. Sujetlana Fajfer

We found the first evidence for the interesting state X(3872) using ab-initio lattice QCD simulations. We performed an exhaustive theoretical analysis of the Higgs' portal models of cosmological dark matter.

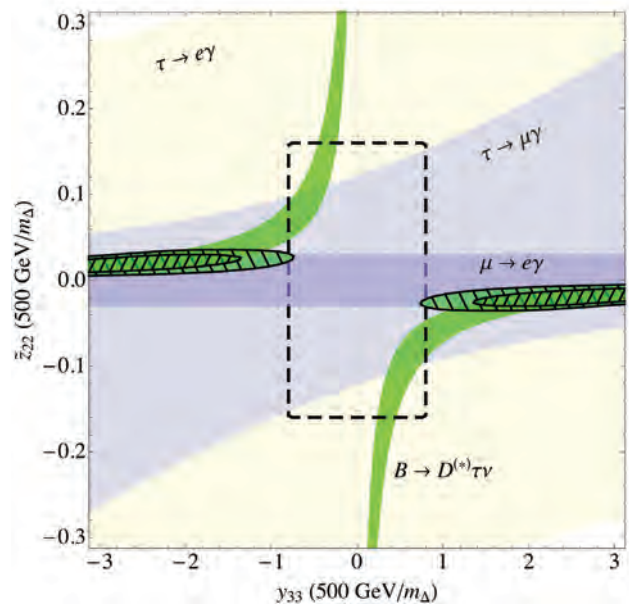


Figure 1: Constraints on the couplings of leptoquark to (bτ) and to (cμ) coming from the 1σ region of $Br(B \rightarrow D^* \tau \nu)$ (thin hyperbolic region), and from 90% CL upper bounds on $\mu \rightarrow e \gamma$, $\tau \rightarrow \mu \gamma$ and $\tau \rightarrow e \gamma$.

Unified Theory we have predicted correlations between the various decay channels of the proton, as well as rare decays of the t-quark and D meson.

We solved the equation for perturbations of a scalar field in AdS with no back-reaction. Through the holographic prescription we showed in this way the existence of a massless pole in the propagator of the boundary theory in the case of vev deformation, in contrast with an earlier claim in the literature.

In the framework of the minimal left-right symmetric model, an original connection between the Dirac and Majorana masses was established. This link removes the indeterminacy of the Dirac mass of neutrinos and allows for a direct correlation between potential measurements of heavy neutrinos and a number of other experiments. We investigated the signals of the Dirac mass at the LHC collider, neutrino-less double beta decay and the electric dipole moment of the electron.

We investigated the problem of positive and negative energies occurring in the quantum field theories in ultra-hyperbolic spaces, and in the theories with higher derivatives. We found that under certain conditions such theories can be stable, for instance, if the interaction potential is bound from below and from above.

Some outstanding publications in the past year

1. Prelovšek, S., Leskovec, L.: Evidence for $X(3872)$ from DD^* scattering on the lattice, Phys.Rev.Lett. 111 (2013)
2. Fajfer, S., Greljo, A., Kamenik, J., Mustać, I.: Light Higgs and vector-like quarks without prejudice. The Journal of high energy physics, ISSN 1126-6708, 2013, vol. 2013, no. 7, 155 (2013)

The group of SOLID STATE THEORY AND STATISTICAL PHYSICS has been investigating the equilibrium and non-equilibrium properties of materials with strongly correlated electrons, nanosystems, as well as the properties of complex networks.

In the theory of non-equilibrium properties of correlated electrons we continued our research of various prototype models with the emphasis on a numerical simulation of undoped and weakly doped Mott insulators. We have investigated the ultra-fast optical response of the one-dimensional Hubbard model that was exposed to two consecutive laser pulses. Using the time-dependent Lanczos method we have discovered that through the selection of the pulse sequence one can excite and de-excite excitons in these systems. In fermion and boson systems

we investigated the basic properties of the out-of-equilibrium dynamics in near-integrable models, also in relation to experiments on ultra-cold atoms on optical lattices. We studied the ultra-fast relaxation and recombination of charged particles that are photo-induced in undoped insulating cuprates and proposed a theory that is based on the emission of multiple magnons and supported it by numerical calculations within the single-band effective model, reaching a good agreement with the measured recombination times. We have introduced the reduced density matrix method to problems of thermal properties of the isolated out-of-equilibrium correlated systems and discovered a deviation from the standard level statistics in the presence of an external field.

On the subject of the equilibrium properties of correlated electrons we have calculated several thermodynamic properties of the Hubbard model on the anisotropic triangular lattice that describes well the organic superconductors and observed numerically the metal-insulator transition. We have investigated the transport in the doped Mott insulators and discovered well-defined, quasi-particle-like excitations well beyond the Fermi liquid regime. Using the dynamical mean-field theory we have established the ferromagnetic phases of the Kondo-lattice and investigated the topological transitions between them. We have investigated the optical response of Fermi liquids. We published a review article on the influence of Hund's rule coupling in multi-orbital metals. Within a model of the disordered Heisenberg spin chain we explained the anomalously broad distribution of the NMR relaxation times in the mixed system BaCuSiGeO. In relation to the new measurements we have investigated the heat transport for a model of weakly coupled antiferromagnetic spin chains. In collaboration with the calorimetry group at the JSI we have modelled the ferroelectric barium titanite and calculated its phase diagram, the specific heat and the electro-caloric effect.

We have investigated the phenomenon of the ultrafast recombination of photo-excited charged particles in undoped insulating cuprates and developed a theory that is based on multiple magnon emission.

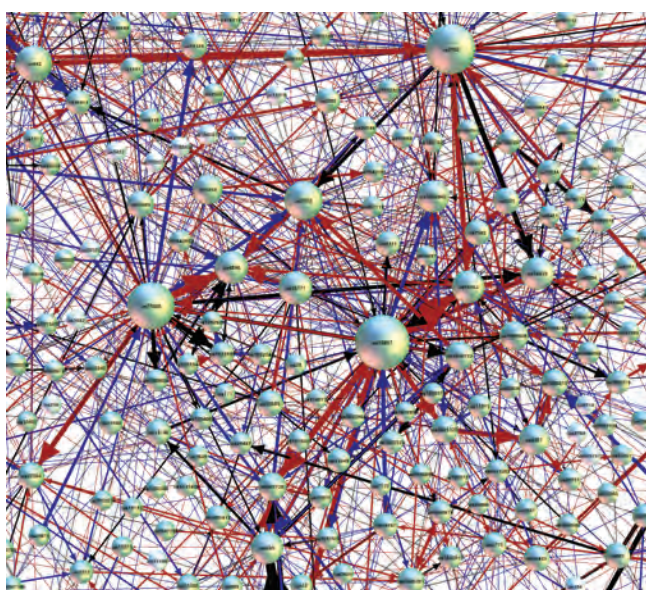


Figure 2: Graph of emotional communications in online chats (the red and black colours indicate messages carrying positive and negative emotions, respectively, while the blue colour shows emotionally neutral messages.)

Within the theory of nanoscale systems we studied the coherent manipulation of the electronic spin in the quantum dot using the time-dependent driving of the harmonic potential and the spin-orbit coupling. We have calculated the spin-Seebeck coefficient for the two-channel Kondo model in the magnetic field and observed the thermal transition between the Fermi-liquid and the non-Fermi-liquid regimes. We have analysed the thermal entanglement in a system of three-spins in the triangular geometry and have shown that the external electric field can induce a maximally entangled state. Using the density functional theory we have investigated the time dependence of the electronic transport through a quantum dot in the Coulomb blockade regime.

In the research on the statistical physics of complex systems and networks we analysed the empirical data from the world wide web and theoretically modelled it. We also simulated nano-systems using mathematical graphs of the nano-network. Within the CYBEREMOTIONS project we investigated the dynamics of the emotional interactions on the web. Theoretical models were devised for certain web-portals. We introduced nano-networks as a concept to determine the complexity at the nano-scale.

Some outstanding publications in the past year

1. Deng, X., Mravlje, J., Žitko, R., Ferrero, M., Kotliar, G., Georges, A.: How bad metals turn good : how bad metals turn good. *Physical review letters*, ISSN 0031-9007, 2013, vol. 110, no. 8, 086401
2. Lenarčič, Z., Prelovšek, P.: Ultrafast charge recombination in a photoexcited Mott-Hubbard insulator. *Physical review letters*, ISSN 0031-9007, 2013, vol. 111, iss. 1, 016401

The group for THEORETICAL BIOPHYSICS AND SOFT MATTER PHYSICS investigated polyelectrolytes, liquid crystals, colloids, and phospholipid and biological membranes.

We worked on several problems in the electrostatics of macromolecular solutions. Within the linearized Debye-Hückel approximation, we analysed the effect of the patchiness of charged macroions on the interactions between them, deriving the conditions for this interaction to be dominant. Also discussed was the interaction between an anisotropic dielectric semi-infinite slab and a moving charge on top of it. We reviewed the recent advances in the field of Coulomb fluids. We showed to what extent they are able to capture effects known to elude the mean-field level of description. We studied the dielectric spectra of DNA in Mg ionic solutions. Various differences are observed when compared to the previously obtained dielectric spectra in monovalent salt solutions and an effort has been made to explain these novel features. Using molecular dynamics simulations, we investigated the properties of biological membranes, focusing on the hydration repulsion between them.

We introduced a model of the helix-coil transition that allows for a straightforward generalization of the effects of solvent structure. In an extensive computational study, we explored the statics and the dynamics of long flexible linear polymers that spontaneously knot and unknot. Also investigated theoretically was the structure of nematic polymers, where we discussed a novel feature in terms of a differential tensorial constraint, which is expected to be important in a macroscopic description of, e.g., DNA ordering in a confined space. With our studies of optical properties of ferrofluids prepared by dispersing ferromagnetic cobalt nanoparticles in cyclohexane, we provided experimental verification of the flexible-chain model for nanoparticles in ferrofluids. We explored the ways of integrating topics on the physics of liquid crystals into undergraduate curricula.

We studied colloidal and nanoparticle ordering in polymer layers. Hard-core colloids form characteristic patterns with a well-defined length scale that can be externally controlled. Our theoretical results suggest several possible applications in miniature sensors, energy production and storage, as well as surface and particle characterization. We analysed the elastic interaction between model 2D colloidal particles and we showed that the non-pairwise aspect of the repulsion between them increases as the particles become more incompressible.

We explored a model of epithelial tissues based on the surface energy of cells, finding that the periodic equilibrium states of the epithelium can be either flat or corrugated. We reviewed the mechanical models of ventral furrow formation in a *Drosophila* embryo. Also investigated was the composite contact of two-component lipid membranes, which includes inverted micelles. Our determination of the positioning of integrin 1 and caveolin-1 on the membrane of adhered spreading cells showed that the presence of one of them spatially excludes the occurrence of the other. Recent experimental results on the aggregation of red blood cells and the corresponding

We have studied the optical properties of ferrofluids and have experimentally verified the flexible chain model, i.e., that nanoparticles in colloid suspensions form flexible chains.

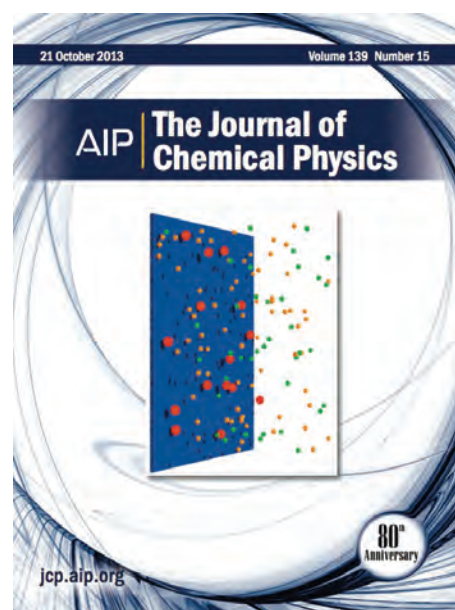


Figure 3: Cover of the *Journal of Chemical Physics* highlighting our review paper on electrostatic interactions A. Naji, M. Kanduč, J. Forsman, and R. Podgornik, »Perspective: Coulomb fluids - weak coupling, strong coupling, in between and beyond«, *J. Chem. Phys.* 139, 150901 (2013).

theoretical analyses of the depletion mechanism and of the influence of the cell shape on the adhesion strength were reviewed. The partitioning of fatty acids into phospholipid membranes was studied on giant unilamellar vesicles, utilizing phase-contrast microscopy, and the observed, enhanced partitioning under conditions of increased membrane strain was interpreted on the basis of a tension-dependent intercalation of oleic acid into the membrane. Finally, we analysed some pertinent questions of physical virology, dealing mostly with charge distribution and the effect of electrostatic interactions on proteinaceous viral shells.

Some outstanding publications in the past year

1. Šiber, A., Ziherl, P.: Many-body contact repulsion of deformable disks. *Physical review letters*, ISSN 0031-9007, 2013, vol. 110, no. 21, 214301
2. Naji, A., Kanduč, M., Forsman, J., Podgornik, R.: Perspective: Coulomb fluids - weak coupling, strong coupling, in between and beyond. *The Journal of chemical physics*, ISSN 0021-9606, 2013, vol. 139, no. 15, 150901

Organization of conferences, congresses and meetings

1. Probing the Standard Model and New Physics at Low and High Energies, Portorož, 14.–18. 4. 2013
2. Physics of Complex Colloids, Ljubljana, 14.–18. 5. 2013
3. Selected Challenges in Particle Phenomenology, Belica, 18.–20. 9. 2013
4. 8th Christmas Biophysics Workshop, Dobrna, 16.–17. 12. 2013
5. Non-equilibrium dynamics of Correlated Electron Systems, Krvavec, 18.–20. 12. 2013

Awards and appointments

1. Jernej Fesl Kamenik: "Svečana listina" award for exceptional scientific and educational achievements, University of Ljubljana
2. Luca Tubiana: Best Ph.D. Thesis in Physics Award, Trieste, Italy, SISSA-ISAS
3. Lev Vidmar: The Jožef Stefan Golden Emblem Prize for doctoral thesis, Jožef Stefan Institute, Ljubljana

INTERNATIONAL PROJECTS

1. 7FP - Cyberemotions; Collective Emotions in Cyberspace
European Commission
Prof. Bosiljka Tadić
2. 7FP - LOTHERM; Low Dimensional Quantum Magnets for Thermal Management
European Commission
Prof. Peter Prelovšek
3. 7FP - COMPLOIDS; Physics of Complex Colloids: Equilibrium and Driven
European Commission
Prof. Primož Ziherl
4. COST TD1210; Analysing the Dynamics of Information and Knowledge Landscapes
COST Office
Prof. Bosiljka Tadić
5. Theoretical Studies of Dynamical Properties in Correlated Electron Systems Coupled to External Degrees of Freedom
Slovenian Research Agency
Prof. Janez Bonča
6. Flavor Violation at the Large Hadron Collider
Slovenian Research Agency
Asst. Prof. Jernej Fesl Kamenik
7. Aspects of the AdS-CFT Correspondence in Particle Physics and Cosmology
Slovenian Research Agency
Prof. Borut Bajc
8. Relaxation Dynamics of Correlated Electron Systems
Slovenian Research Agency
Prof. Janez Bonča

RESEARCH PROGRAMS

1. Theory of the Condensed Matter and Statistical Physics
Prof. Janez Bonča
2. Theoretical Physics of Nuclei, Particles and Fields
Prof. Svetlana Fajfer
3. Biophysics of Polymers, Membranes, Gels, Colloids and Cells
Prof. Rudolf Podgornik

R&D GRANTS AND CONTRACTS

1. Theoretical Aspects and Empirical Analysis of Labour Market Impact of Flexicurity
Dr. Jernej Mravlje
2. Integrability and Ergodic Theory of Non-equilibrium Quantum Many-body Systems
Dr. Jernej Mravlje
3. Non-equilibrium Dynamics of Interacting Electron Systems
Prof. Peter Prelovšek
4. Synergies between precision measurements and LHC discoveries
Asst. Prof. Jernej Fesl Kamenik
5. Investigation of Strongly Interacting Electron Systems by a Computational Study of a Model for Organic Superconductors
Dr. Jure Kokalj

VISITORS FROM ABROAD

1. Dr. Christoph Bobet, Technische Universität, München, Germany, 9.–11. 1. 2013
2. Dr. Robin Steinigeweg, Institut für theoretische Physik, Technische Universität Braunschweig, Braunschweig, Germany, 22.–27. 1., 26.–30. 11. 2013
3. Prof. Marcin Mierzejewski, University of Katowice, Poland, 6.–16. 2. 2013
4. Prof. David Sherrington, University of Oxford, Oxford, Great Britain, 13.–14. 2. 2013
5. Prof. Adrian Lugo, Departamento de Física and IFLP-CONICET, Facultad de Ciencias Exactas, Universidad Nacional de La Plata, La Plata, Argentina, 14. 2.–14. 3. 2014
6. Dr. Pieralberto Marchetti, University of Padova, Padova, Italy, 20.–23. 2. 2013
7. Prof. Sadamichi Maekawa, Dr. Kenji Tsutsui, Prof. Takami Tohyama, Dr. Hantao Lu,
8. Dr. Wataru Koshibae, Koudai Sugimoto, Kazuya Shinjo, Shigetoshi Sota, Yukawa Institute of Theoretical Physics, Kyoto University, Kyoto, Japan, 19.–21. 2. 2013
9. Dr. Krešimir Kumerički, Prirodoslovno matematički fakultet, Sveučilište u Zagrebu, Zagreb, Croatia, 21. 2. 2013
10. Prof. Jan O. Eeg, Physics Department, Oslo University, Oslo, Norway, 25. 2.–1. 3. 2013

11. Dr. Marco Berrita, University of Lancaster, Lancaster, Great Britain, 28. 2.–28. 3., 25. 11.–8. 12. 2013
12. Dr. Marco Budinich, ICTP and University of Trieste, Trieste, Italy, 18.–19. 3. 2013
13. Dr. Valentina Verduci, University of Graz, Graz, Austria, 20.–21. 3. 2013
14. Prof. Christian Wagner, Experimentalphysik Universität des Saarlandes, Saarbrücken, Germany, 20.–22. 3. 2013
15. Prof. Günther Meissner, Universität des Saarlandes, Saarbrücken and Technische Universität München, Germany, 25.–27.3.2013
16. Dr. Joachim Kopp, Max Planck Institute Heidelberg, Germany, 28.–29. 3. 2013
17. Prof. Frank Marsiglio, Department of Physics, University of Alberta and Physics Division, School of Science and Technology, University of Camerino, Italy, 2.–3. 4. 2013
18. Dr. Benoit Schmauch, University of Saclay, Paris, France, 21.–25. 4. 2013
19. Denis Parganlija, Vienna University of Technology, Vienna, Austria, 24.–26. 4. 2013
20. Prof. Oleg Shushkov, University of South Wales, Sydney, Australia, 8.–13. 6. 2013
21. Prof. Rodolfo Jalabert, l'Institut de Physique et Chimie des Matériaux de Strasbourg and IPCMS, Département Magnétisme des Objets NanoStructurés, Strasbourg, France, 1.–5. 7. 2013
22. Prof. Ilja Doršner, Univerza v Sarajevu, Institut za naravoslovje in matematiko, Sarajevo, BOSNIA, 6. 7.–18. 8., 13.–16. 10., 27.–30. 11., 15.–21. 12. 2013
23. Dr. Luca Di Luzio, Institut für Theoretische Teilchenphysik, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, 31. 7.–4. 8. 2013
24. Prof. Tomonari Dotera, Kinki University, Osaka, Japan, 26.–31. 8. 2013
25. Dr. Berin Belma Sirvanli, Gazi University, Arts and Sciences Faculty, Department of Physics, Ankara, Turkey, 2. 9.–30. 11. 2013
26. Michael Park, Rutgers University, New Jersey, USA, 3.–6. 9. 2013
27. Dr. Dilip Ghosh, IACS, Kolkata, India, 12. 9. 2013
28. Prof. Josef Nir, Weizmann Institute, Rehovot, Israel, 15.–18. 9. 2013
29. Dr. Pablo Vazquez-Monteo, Departamento de Matemáticas Aplicadas y Sistemas, Universidad Autónoma Metropolitana-Cuajimalpa, Mexico, 22.–28. 9. 2013
30. Prof. Ross McKenzie, University of Queensland, Brisbane, Australia, 27. 9.–13. 10. 2013
31. Dr. Stephane Lavignac, Saclay University, Paris, France, 29. 9.–4. 10. 2013
32. Sahib Babae Tooski, Division of Theory of Solid State Physics, Institute of Molecular Physics, Polish Academy of Sciences, Poznań, Poland, 2.–24. 10. 2013
33. Dr. Giannis Georgiou, Technische Universität Wien, Vienna, Austria, 6.–12. 10. 2013
34. Prof. Kaladi Babu, Oklahoma State University, Stillwater, USA, 7.–8. 10. 2013
35. Prof. Qaisar Shafi, Bartol Research Institute, University of Delaware, Delaware, USA, 15. 10. 2013
36. Dr. Takehiro Jimbo, Tohoku University, Sendai, Japan, 20. 10.–20. 11. 2013
37. Dr. Osor Slaven Barišić, Institut za fiziku, Zagreb, Croatia, 23.–24. 10. 2013
38. Prof. Masayuki Imai, Ochanomizu University, Tokyo, Japan, 13.–17. 11. 2013
39. Dr. Gabrijele Zaharijas, ICTP, Trieste, Italy, 14. 11. 2013
40. Dr. Markus Aichhorn, Technische Universität, Graz, Austria, 14.–16. 11. 2013
41. Antione Gerardine, Laboratoire de Physique Theorique d'Orsay, Orsay, France, 20.–22. 11. 2013
42. Prof. J. H. Jefferson, University of Oxford and QinetiQ, Great Malvern, Great Britain, 24. 11.–1. 12. 2013
43. Dr. Matteo Rauzi, European Molecular Biology Laboratory, Heidelberg, Germany, 25.–26. 11. 2013
44. Prof. Xenophon Zotos, University of Crete, Heraklion, Greece, 27.–30. 11. 2013

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Researchers

1. Prof. Borut Bajc
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19. Dr. Igor Sega
20. *Prof. Saša Svetina, left 01.10.13*
21. *Dr. Milovan Šuvakov, left 01.03.13*
22. Prof. Bosiljka Tadić
23. Prof. Nataša Vaupotič*
24. Prof. Primož Zihnerl*
25. Asst. Prof. Jure Zupan
26. Dr. Rok Žitko
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28. Dr. Jure Drobnak

29. *Dr. Ana Hočevar Brezavšček, left 02.07.13*
30. *Dr. Julio Julio, left 01.10.13*
31. Dr. Matej Kanduč
32. *Dr. Anže Lošdorfer Božič, left 01.11.13*
33. Dr. Uroš Tkalec
34. Dr. Luca Tubiana
35. Dr. Lev Vidmar
36. Dr. Mihael-Matjaž Zemljic*
- Postgraduates**
37. Nataša Adžić
38. *Lamprini Athanasopoulou, B. Sc., left 01.11.13*
39. Denis Golež, B. Sc.
40. Admir Greljo, B. Sc.
41. *Jacek Wojciech Herbrych, M. Sc., left 01.09.13*
42. *Dr. Tilen Huljev Čadež, left 01.06.13*
43. Urška Jelerčić, B. Sc.
44. Jan Kogoj, B. Sc.
45. Matej Krajnc, B. Sc.
46. Ambrož Kregar, B. Sc.
47. Zala Lenarčič, B. Sc.
48. Luka Leskovec, B. Sc.
49. *Dr. Timon Mede, left 01.04.13*
50. Ivan Nišandžić, B. Sc.
51. Žiga Osolin, B. Sc.
52. Vasja Susič, B. Sc.
- Technical and administrative staff**
53. Nevenka Hauschild

Note:

* part-time JSI member

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Artem V. Badasyan, Achille Giacometti, Rudolf Podgornik, Yevgeni S. Mamasakhlisov, Vladimir Morozov, "Helix-coil transition in terms of Potts-like spins", *Eur. Phys. J. E*, vol. 36, issue 5, art.no. 46, 9 pp., 2013.
2. Borut Bajc, Adrián Lugo, "On the matching method and the Goldstone theorem in holography", *J. high energy phys.*, vol. 2013, issue 7, pp. 56-1-56-16, 2013.
3. Christophe Berthod, Jernej Mravlje, Xiaoyu Deng, Rok Žitko, Dirk van der Marel, Antoine Georges, "Non-Drude universal scaling laws for the optical response of local Fermi liquids", *Phys. rev. B, Condens. matter mater. phys.*, vol. 87, no. 11, pp. 115109-1-115109-15, 2013.
4. A. Bharucha *et al.* (44 authors), "Implications of LHCb measurements and future prospects", *Eur. Phys. J. C*, vol. 73, no. 4, pp. 2373-1-2373-92, 2013.
5. Oliver Bodensiek, Rok Žitko, Matthias Vojta, Mark Jarrel, Thomas Pruschke, "Unconventional superconductivity from local spin fluctuations in the Kondo lattice", *Phys. rev. Lett.*, vol. 110, no. 14, pp. 146406-1-146406-5, 2013.
6. Tine Curk *et al.* (16 authors), "Chemotactic sensing towards ambient and secreted attractant drives collective behaviour of *E. coli*", *PLoS one*, vol. 8, no. 10, pp. e4878-1-e4878-9, 2013.
7. Tine Curk, Francisco J. Martinez-Veracoechea, Daan Frenkel, Jure Dobnikar, "Collective ordering of colloids in grafted polymer layers", *Soft matter*, vol. 9, iss. 23, pp. 5565-5571, 2013.

8. Tilen Čadež, J. H. Jefferson, Anton Ramšak, "A non-adiabatically driven electron in a quantum wire with spin-orbit interaction", *New journal of physics*, vol. 15, pp. 013029-1-013029-11, 2013.
9. David S. Dean, Vozken Adrian Parsegian, Rudolf Podgornik, "Fluctuation of thermal van der Waals forces due to dipole fluctuations", *Phys. rev. A*, vol. 87, iss. 3, pp. 032111-1-032111-5, 2013.
10. Cédric Delaunay, Jernej Kamenik, Gilad Perez, Lisa Randall, "Charming CP violation and dipole operators from RS flavor anarchy", *J. high energy phys.*, vol. 2013, no. 1, pp. 27-1-27-23, 2013.
11. Xiaoyu Deng, Michel Ferrero, Jernej Mravlje, Markus Aichhorn, Antoine Georges, "Hallmark of strong electronic correlations in LaNiO_3 : photoemission kink and broadening of fully occupied bands", *Phys. rev. B, Condens. matter mater. phys.*, vol. 85, no. 12, pp. 125137-1-125137-5, 2013.
12. Xiaoyu Deng, Jernej Mravlje, Rok Žitko, Michel Ferrero, Gabriel Kotliar, Antoine Georges, "How bad metals turn good: how bad metals turn good", *Phys. rev. lett.*, vol. 110, no. 8, pp. 086401-1-086401-5, 2013.
13. Sébastien Descotes-Genon, Jernej Kamenik, "A possible explanation of the D0 like-sign dimuon charge asymmetry", *Phys. rev. D Part. fields gravit. cosmol.*, vol. 87, no. 7, pp. 074036-1-074036-7, 2013.
14. Ilja Doršner, Svetlana Fajfer, Nejc Košnik, Ivan Nišandžić, "Minimally flavored colored scalar in $\bar{B} \rightarrow D^{(*)} \tau \bar{\nu}$ and the mass matrices constraints", *J. high energy phys.*, vol. 2013, no. 11, pp. 081-1-081-31.
15. Svetlana Fajfer, Admir Greljo, Jernej Kamenik, Ivana Mustać, "Light Higgs and vector-like quarks without prejudice", *J. high energy phys.*, vol. 2013, no. 7, pp. 155-1-155-37, 2013.
16. Svetlana Fajfer, Nejc Košnik, "Resonance catalyzed CP asymmetries in $D \rightarrow P \ell^+ \ell^-$ ", *Phys. rev. D Part. fields gravit. cosmol.*, vol. 87, no. 5, pp. 054026-1-054026-8, 2013.
17. Antoine Georges, Luca de' Medici, Jernej Mravlje, "Strong correlations from Hund's coupling", *Annu. rev. condens. matter phys.*, vol. 4, pp. 137-178, 2013.
18. Vladimir Gligorijević, Marcin Skowron, Bosiljka Tadić, "Structure and stability of online chat networks built on emotion-carrying links", *Physica A*, vol. 392, no. 3, pp. 538-543, 2013.
19. Denis Golež, Rok Žitko, "Lifshitz phase transitions in the ferromagnetic regime of the Kondo lattice model", *Phys. rev. B, Condens. matter mater. phys.*, vol. 88, no. 5, pp. 054431-1-054431-6, 2013.
20. Bojan Golji, Simon Širca, "A chiral quark model for meson electroproduction in the region of D-wave resonances", *Eur. Phys. J. A*, vol. 49, iss. 9, 11 pp., 2013.
21. Admir Greljo, J. Julio, Jernej Kamenik, Christopher Smith, Jure Zupan, "Constraining Higgs mediated dark matter interactions", *J. high energy phys.*, vol. 2013, no. 11, pp. 190-1-190-30, 2013.
22. D. Grgičin, Sanja Dolanski Babić, T. Ivek, Silviija Tomić, Rudolf Podgornik, "Effect of magnesium ions on dielectric relaxation in semidilute DNA aqueous solutions", *Phys. rev. E Stat. nonlinear soft matter phys.*, vol. 88, iss. 5, pp. 052703-1-052703-8, 2013.
23. Jacek Herbrych, Jure Kokalj, Peter Prelovšek, "Local spin relaxation within the random Heisenberg chain", *Phys. rev. lett.*, vol. 111, no. 14, pp. 147203-1-147203-5, 2013.
24. Leili Javidpour, Anže Lošdorfer Božič, Ali Naji, Rudolf Podgornik, "Electrostatic stability and encapsidation of charged nano-droplets", *Soft matter*, vol. 9, iss. 47, pp. 11357-11366, 2013.
25. Leili Javidpour, Anže Lošdorfer Božič, Ali Naji, Rudolf Podgornik, "Multivalent ion effects on electrostatic stability of virus-like nano-shells", *J. chem. phys.*, vol. 139, iss. 15, pp. 154709-1-154709-7, 2013.
26. Urška Jelerčič, Primož Zihnerl, "Composite contact of binary lipid membranes", *Eur. Phys. J. E*, vol. 36, no. 8, pp. 89-1-89-7, 2013.
27. Jernej Kamenik, "Hunting new physics with lepton flavor universality violations in B decays and asymmetries in top pair production", In: Proceedings of the Fourth Workshop on Theory, phenomenology and Experiments in heavy Flavour Physics, 11-13 June 2012, Anacapri, Italy, *Nucl. Phys. B, Proc. Suppl.*, vol. 241/242, pp. 146-151, 2013.
28. Matej Kanduč, Emanuel Schneck, R. R. Netz, "Hydration interaction between phospholipid membranes: insight into different measurement ensembles from atomistic molecular dynamics simulations", *Langmuir*, vol. 29, no. 29, pp. 9126-9137, 2013.
29. Jure Kokalj, Ross H. McKenzie, "Thermodynamics of a bad metal - Mott insulator transition in the presence of frustration", *Phys. rev. lett.*, vol. 110, no. 20, pp. 206402-1-206402-5, 2013.
30. Matej Krajnc, N. Štorgel, Ana Hočevar Brezavšček, Primož Zihnerl, "A tension-based model of flat and corrugated simple epithelia", *Soft matter*, vol. 9, no. 34, pp. 8368-8377, 2013.
31. Zala Lenarčič, Peter Prelovšek, "Ultrafast charge recombination in a photoexcited Mott-Hubbard insulator", *Phys. rev. lett.*, vol. 111, iss. 1, pp. 016401-1-016401-5, [1] f. pril., 2013.
32. Rosa López, Tomaž Rejec, Jan Martinek, Rok Žitko, "SU(3) Kondo effect in spinless triple quantum dots", *Phys. rev. B, Condens. matter mater. phys.*, vol. 87, no. 3, pp. 035135-1-035135-12, 2013.
33. Anže Lošdorfer Božič, Rudolf Podgornik, "Symmetry effects in electrostatic interactions between two arbitrarily charged spherical shells in the Debye-Hückel approximation", *J. chem. phys.*, vol. 138, no. 7, pp. 074902-1-074902-14, 2013.
34. Anže Lošdorfer Božič, Antonio Šiber, Rudolf Podgornik, "Statistical analysis of sizes and shapes of virus capsids and their resulting elastic properties", *J. Biol. Phys.*, vol. 39, iss. 2, pp. 215-228, 2013.
35. Hantao Lu, Janez Bonča, Takami Tohyama, "Double-pulse deexcitations in a one-dimensional strongly correlated system", *Europhys. lett.*, vol. 103, no. 5, pp. 57005-p1-57005-p5, 2013.
36. Mojca Mally, Primož Peterlin, Saša Svetina, "Partitioning of oleic acid into phosphatidylcholine membranes is amplified by strain", *J. phys. chem. B, Condens. mater. surf. interfaces biophys.*, vol. 117, iss. 40, pp. 12086-12094, Oct. 2013.
37. Marcin Mierzejewski, Tomaž Prosen, D. Crivelli, Peter Prelovšek, "Eigenvalue statistics of reduced density matrix during driving and relaxation", *Phys. rev. lett.*, vol. 110, iss. 20, pp. 200602-1-200602-5, 2013.
38. Daniel Mohler, Christian B. Lang, Luka Leskovec, Saša Prelovšek, Richard M. Woloshyn, " $D_{s0}^*(2317)$ meson and D-meson-kaon scattering from lattice QCD", *Phys. rev. lett.*, vol. 111, iss. 22, pp. 222001-1-222001-5, 2013.
39. Daniel Mohler, Saša Prelovšek, Richard M. Woloshyn, " $D\pi$ scattering and D meson resonances from lattice QCD", *Phys. rev. D Part. fields gravit. cosmol.*, vol. 87, iss. 3, pp. 034501-1-034501-18, 2013.
40. Ali Naji, Matej Kanduč, J. Forsman, Rudolf Podgornik, "Perspective: Coulomb fluids - weak coupling, strong coupling, in between and beyond", *J. chem. phys.*, vol. 139, no. 15, pp. 150901-1-150901-13, 2013.
41. Miha Nemevšek, "Vacuum, colliders, and the origin of mass", In: *The structure of the void*, (Filozofski vestnik, 2013, 2), Mladen Dolar, ed., et al. Ljubljana, Filozofski inštitut ZRC SAZU, = Institute of Philosophy at SRC SASA, 2013, pp. 79-98.
42. Miha Nemevšek, Goran Senjanović, Vladimir Tello, "Connecting dirac and majorana neutrino mass matrices in the minimal left-right symmetric model", *Phys. rev. lett.*, vol. 110, no. 15, pp. 151802-1-151802-5, 2013.
43. Nikola Novak, Zdravko Kutnjak, Raša Pirc, "High-resolution electrocaloric and heat capacity measurements in barium titanate", *Europhys. lett.*, vol. 103, no. 4, pp. 47001-1-47001-5, 2013.
44. Nikola Novak, Raša Pirc, Zdravko Kutnjak, "Diffuse critical point in PLZT ceramics", *Europhys. lett.*, vol. 102, no. 1, pp. 17003-1-17003-5, 2013.
45. Nikola Novak, Raša Pirc, Zdravko Kutnjak, "Impact of critical point on piezoelectric and electrocaloric response in barium titanate", *Phys. rev. B, Condens. matter mater. phys.*, vol. 87, no. 10, pp. 104102-1-104102-5, 2013.
46. Žiga Osolin, Rok Žitko, "Padé approximant approach for obtaining finite-temperature spectral functions of quantum impurity models using the numerical renormalization group technique", *Phys. rev. B, Condens. matter mater. phys.*, vol. 87, no. 24, pp. 245135-1-245135-18, 2013.
47. Jerneja Pavlin, Nataša Vaupotič, Mojca Čepič, "Direction dependence of the extraordinary refraction index in uniaxial nematic liquid crystals", *Eur. j. phys.*, vol. 34, no. 2, pp. 331-344, 2013.
48. Jerneja Pavlin, Nataša Vaupotič, Mojca Čepič, "Liquid crystals: a new topic in physics for undergraduates", *Eur. j. phys.*, vol. 34, no. 3, pp. 745-761, 2013.
49. Matej Pavšič, "Localized propagating tachyons in extended relativity theories", *Adv. appl. Clifford algebr.*, vol. 23, no. 2, pp. 469-495, 2013.
50. Matej Pavšič, "Pais-Uhlenbeck oscillator with a benign friction force", *Phys. rev. D Part. fields gravit. cosmol.*, vol. 87, no. 10, pp. 107502-1-107502-3, 2013.
51. Matej Pavšič, "Stable self-interacting Pais-Uhlenbeck oscillator", *Mod. phys. lett. A*, vol. 28, no. 36, pp. 1350165-1-1350165-15, 2013.
52. J.-D. Pillet, P. Joyez, Rok Žitko, M. F. Goffman, "Tunneling spectroscopy of a single quantum dot coupled to a superconductor: from Kondo ridge to Andreev bound states", *Phys. rev. B, Condens. matter mater. phys.*, vol. 88, no. 4, pp. 045101-1-045101-6, 2013.
53. Saša Prelovšek, Luka Leskovec, "Evidence for X(3872) from DD* scattering on the lattice", *Phys. rev. lett.*, vol. 111, iss. 19, pp. 192001-1-192001-5, 2013.
54. Saša Prelovšek, Luka Leskovec, "Search for Z_c^+ (3900) in the 1^{+-} channel on the lattice", *Phys. lett. Sect. B*, vol. 727, iss. 1/3, pp. 172-176, 2013.

55. Saša Prelovšek, Luka Leskovec, Christian B. Lang, Daniel Mohler, " $K\pi$ scattering and the K^+ decay width from lattice QCD", *Phys. rev. D Part. fields gravit. cosmol.*, vol. 88, iss. 5, pp. 054508-1-054508-12, 2013.
56. Albert Prodan, Herman J. P. van Midden, Erik Zupanič, Rok Žitko, "Nanostructured and modulated low-dimensional systems", In: Proceedings of the XXII Conference on Applied Crystallography, 2-6 September 2012, Targanice, Poland, *Solid State Phenom.*, vol. 203-204, pp. 42-47, 2013.
57. Rick F. Rajter, Roger H. French, Wai-Yim Ching, Rudolf Podgornik, Vozken Adrian Parsegian, "Chirality-dependent properties of carbon nanotubes: electronic structure, optical dispersion properties, Hamaker coefficients and van der Waals-London dispersion interactions", *RSC advances*, vol. 3, iss. 3, pp. 823-842, 2013.
58. Primož Rebernik Ribič, Rudolf Podgornik, "Interaction of a point charge with the surface of a uniaxial dielectric", *Europhys. lett.*, vol. 102, no. 2, pp. 24001-p1-24001-p6, 2013.
59. Jalal Sarabadani, Ali Naji, Reza Asgari, Rudolf Podgornik, "Erratum: Many-body effects in the van der Waals-Casimir interaction between graphene layers [Phys. Rev. B 84, 155407 (2011)]", *Phys. rev. B, Condens. matter mater. phys.*, vol. 87, iss. 23, pp. 239905-1-239905-2, 2013.
60. Anupam Sengupta, Uroš Tkalec, Miha Ravnik, Julia M. Yeomans, Christian Bahr, Stephan Herminghaus, "Liquid crystal microfluidics for tunable flow shaping", *Phys. rev. lett.*, vol. 110, iss. 4, pp. 048303-1-048303-5, 2013.
61. Daniel Svenšek, G. M. Grason, Rudolf Podgornik, "Tensorial conservation law for nematic polymers", *Phys. rev. E Stat. nonlinear soft matter phys.*, vol. 88, iss. 5, pp. 052603-1-052603-7, 2013.
62. Jacek Szczytko, Nataša Vaupotič, Karolina Madrak, Paweł Sznajder, Ewa Górecka, "Magnetic moment of a single metal nanoparticle determined from the Faraday effect", *Phys. rev. E Stat. nonlinear soft matter phys.*, vol. 87, no. 3, 033201-1-033201-6, 2013.
63. Jacek Szczytko, Nataša Vaupotič, Mihail A. Opisov, Karolina Madrak, Ewa Górecka, "Effect of dimerization on the field-induced birefringence in ferrofluids", *Phys. rev. E Stat. nonlinear soft matter phys.*, vol. 87, no. 6, pp. 062322-1-062322-6, 2013.
64. Antonio Šiber, Primož Zihlerl, "Many-body contact repulsion of deformable disks", *Phys. rev. lett.*, vol. 110, no. 21, pp. 214301-1-214301-5, 2013.
65. Bosiljka Tadić, Vladimir Gligorijević, Marija Mitrović, Milovan Šuvakov, "Co-evolutionary mechanisms of emotional bursts in online social dynamics and networks", *Entropy (Basel, Online)*, vol. 15, no. 12, pp. 5083-5120, 2013.
66. Bosiljka Tadić, Milovan Šuvakov, "Can human-like Bots control collective mood: agent-based simulations of online chats", *J. stat. mech.*, vol. 2013, pp. P10014-1-P1004-22, okt. 2013.
67. Luca Tubiana, A. Rosa, F. Fragiaco, C. Micheletti, "Spontaneous knotting and unknotting of flexible linear polymers: equilibrium and kinetic aspects", *Macromolecules*, vol. 46, no. 9, pp. 3669-3678, 2013.
68. M. Urbaniak, S. B. Tooski, Anton Ramšak, B. R. Bužka, "Thermal entanglement in a triple quantum dot system", *Eur. phys. j., B Cond. matter phys.*, vol. 86, iss. 12, 8 pp., 2013.
69. Lev Vidmar, Janez Bonča, "Two holes in the t-J model form a bound state for any nonzero J/t ", *J. supercond. nov. magn.*, vol. 26, iss. 8, pp. 2641-2645, 2013.
70. Lev Vidmar, S. Langer, I. P. McCulloch, U. Schneider, U. Schollwöck, F. Heidrich-Meisner, "Sudden expansion of Mott insulators in one dimension", *Phys. rev. B, Condens. matter mater. phys.*, vol. 88, no. 23, pp. 235117-1-235117-16, 2013.
71. Christian Wagner, Patrick Steffen, Saša Svetina, "Aggregation of red blood cells: from rouleaux to clot formation: de la formation des rouleaux à celle des caillots", *C. r. - Acad. sci., Phys.*, vol. 14, iss. 6, pp. 459-469, 2013.
72. Špela Zemljič Jokhadar, Janja Majhenc, Saša Svetina, Urška Batista, "Positioning of integrin [beta]1, caveolin-1 and focal adhesion kinase on the adhered membrane of spreading cells", *Cell Biol Int*, vol. 37, iss. 12, pp. 1276-1284, 2013.
73. Špela Zemljič Jokhadar, Janja Majhenc, Saša Svetina, Urška Batista, "Positioning of integrin [beta]1, caveolin-1 and focal adhesion kinase on the adhered membrane of spreading cells", *J. phys. chem., B Condens. matter. surf. interfaces biophys.*, vol. 37, iss. 12, pp. 1276-1284, Dec. 2013.
74. Anna Zep, Mirosław Salamonczyk, Nataša Vaupotič, Damian Pocięcha, Ewa Górecka, "Physical gels made of liquid crystalline B_2 phase", *Chem. commun. (Lond., 1996)*, vol. 49, issue 30, pp. 3119-3121, 2013.
75. Saša Zihlerl, Jure Bajc, Mojca Čepič, "Refraction and absorption of microwaves in wood", *Eur. j. phys.*, vol. 34, no. 2, pp. 449-459, 2013.
76. Rok Žitko, D. Hansen, E. Perepelitsky, Jernej Mravlje, Antoine Georges, B. S. Shastry, "Extremely correlated Fermi liquid theory meets dynamical mean-field theory: analytical insights into the doping-driven Mott transition", *Phys. rev. B, Condens. matter mater. phys.*, vol. 88, no. 23, pp. 235132-1- 235132-18, 2013.
77. Rok Žitko, Jernej Mravlje, Anton Ramšak, Tomaž Rejec, "Spin thermopower in the overscreened Kondo model", *New journal of physics*, vol. 15, pp. 105023-1-105023-15, 2013.

REVIEW ARTICLE

- Jure Dobnikar, Alexey Snezhko, Anand Yethiraj, "Emergent colloidal dynamics in electromagnetic fields", *Soft matter*, vol. 9, no. 14, pp. 3693-1-3693-12, 2013.
- Matteo Rauzi, Ana Hočevar Brezavšček, Primož Zihlerl, Maria Leptin, "Physical models of mesoderm invagination in *Drosophila* embryo", *Biophys. j.*, vol. 105, no. 1, pp. 3-10, 2013.
- Uroš Tkalec, Igor Mušević, "Topology of nematic liquid crystal colloids confined to two dimensions", *Soft matter*, vol. 9, issue 34, pp. 8140-8150, 2013.
- Jelena Živković, Bosiljka Tadić, "Nanonetworks: the graph theory framework for modeling nanoscale systems", *Nanoscale systems*, vol. 2, pp. 30-48, 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

- Saša Prelovšek, "Lattice QCD review of charmonium and open-charm spectroscopy", V: *Proceedings of the 6th International Workshop on Charm Physics, CHARM 2013, Manchester, UK, 31 August - 4 September, 2013*, Marco Gersabeck, ed., Chris Parkes, ed., Menlo Park, SLAC National Accelerator Laboratory, 2013, 11 pp.
- Saša Prelovšek, Christian B. Lang, Luka Leskovec, Daniel Mohler, Richard M. Woloshyn, "Hadronic resonances in lattice QCD", In: *International Meeting Excited QCD, Bjelašnica Mountain, Sarajevo, Bosnia - Herzegovina, February 3-9, 2013*, (Acta Physica Polonica, B, Proceedings Supplement, vol. 6, no. 3, 2013), Pedro Bicudo, ed., Cracow, Polish Academy of Arts and Sciences, Jagiellonian University, M. Smoluchowski Institute of Physics, 2013, pp. 879-885.

PUBLISHED CONFERENCE CONTRIBUTION

- Jure Dobnikar, Tine Curk, Francisco J. Martinez-Veracoechea, Daan Frenkel, "Slow colloidal dynamics in polymer brushes", In: *International symposium on slow dynamics in complex systems, Sendai, Japan, 2-7 December 2012: keep going Tohoku*, (AIP conference proceedings, 1518), Michio Tokuyama, ed., Irwin Oppenheim, ed., Melville (NY), American Institute of Physics, 2013, pp. 391-397.
- Bojan Golli, Simon Širca, "Electroexcitation of the D-wave resonance", In: *Proceedings to the Mini-Workshop Looking into Hadrons, Bled, Slovenia, July 7-14, 2013*, (Blejske delavnice iz fizike, vol. 14, no. 1), Bojan Golli, ed., Mitja Rosina, ed., Simon Širca, ed., Ljubljana, DMFA - založništvo, 2012, vol. 14, no. 1, pp. 43-44, 2013.
- S. Groot, Jürgen G. Körner, Blaženka Melić, Saša Prelovšek, "Single top quark polarization at $O(\alpha_s)$ in $t\bar{t}$ production at a polarized linear e^+e^- collider", In: *Proceedings of the workshops, Helmholtz Alliance Linear Collider Forum, Hamburg, Munich, Hamburg 2010-2012, Germany*, Pick G. Moortgat, ed., Hamburg, Verlag Deutsches Elektronen-Synchrotron, 2013, pp. 118-125.
- N. E. Hussey, H. Gordon-Moys, Jure Kokalj, Ross H. McKenzie, "Generic strange-metal behaviour of overdoped cuprates", In: *10th International Conference on Materials and Mechanisms of Superconductivity, 29 July to 3 August 2012, Washington, DC, USA*, (Journal of physics, Conference series, vol. 449, 2013), Bristol, Institute of Physics, 2013, vol. 449, pp. 012004-1-012004-8, 2013.
- Jernej Kamenik, "Hunting new physics in top pair production", In: *Proceedings of the XXth International Workshop on Deep-Inelastic Scattering and Related Subjects, DIS 2012, 26-30 March 2012, Bonn, Germany*, Ian C. Brock, ed., Hamburg, verlag Deutsche Elektronen-Synchrotron, 2013, pp. 351-354.
- Nejc Košnik, Damir Bečirević, Andrey Tayduganov, "Testing the SM in $B \rightarrow D\tau\nu$ decay with minimal theory input", In: *Proceedings of the Xth Quark Confinement and the Hadron Spectrum, October 8-12, 2012, Munich, Germany*, (PoS proceedings of science, vol. 2013, 20213), Trieste, Sissa, 2013, vol. 2013, pp. 244-1-244-8, 2013.

7. Miha Nemevšek, "Low scale left-right symmetry and warm dark matter", In: *Proceedings of the Workshop on Dark Matter, Unification and Neutrino Physics, 10 July-1 August 2012, South Dakota, Lead/Deadwood, South Dakota, USA*, (AIP conference proceedings, vol. 1534, 2013), New York, American Institute of Physics, 2013, vol. 1534, pp. 112-121, 2013.
8. Matej Pavšič, "Quantum field theories in spaces with neutral signatures", In: *Proceedings of the IARD 2012, 8th Biennial Conference on Classical and Quantum Relativistic Dynamics of Particles and Fields, 29 May - 1 June 2012, Florence, Italy*, (Journal of physics, Conference series, vol. 437, 2013), Bristol, Institute of Physics Publishing, 2013, vol. 437, pp. 012006--1-012006-29, 2013.
9. Saša Prelovšek, "Charmonium-like states and K^* resonances", In: *Proceedings to the Mini-Workshop Looking into Hadrons, Bled, Slovenia, July 7-14, 2013*, (Blejske delavnice iz fizike, vol. 14, no. 1), Bojan Golli, ed., Mitja Rosina, ed., Simon Širca, ed., Ljubljana, DMFA - založništvo, 2012, vol. 14, no. 1, pp. 50-51, 2013.
10. Silvija Tomič, D. Grgičin, Tomislav Vuletić, Sanja Dolanski Babić, T. Ivek, Rudolf Podgornik, "DNA in aqueous solutions with repulsive interactions: structure determined on the basis of dielectric spectroscopy measurements", V: *Bioinformatics and biological physics: proceedings of the scientific meeting*, November 21, 2012, Zagreb, Vladimir Paar, ed., Zagreb, Hrvatska akademija znanosti i umjetnosti, 2013, str. 159-177.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Peter Prelovšek, Janez Bonča, "Ground state and finite temperature Lanczos methods", In: *Strongly correlated systems: numerical methods*, (Springer series in solid-state sciences, vol. 176), Adolfo Avella, ed., Ferdinando Mancini, ed., Berlin, Heidelberg, Springer, cop. 2013, pp. 1-30.

2. Bosiljka Tadić, "Modeling behavior of web users as agents with reason and sentiment", In: *Advances in computational modeling research: theory, developments and applications*, (Computer science technology and applications), Anna Belya Kora, ed., New York, Nova Science, 2013, pp. 177-186.

MENTORING

1. Tilen Čadež, *Quantum entanglement in systems of strongly interacting electrons*: doctoral dissertation, Ljubljana, 2013 (mentor Anton Ramšak).
2. Jacek Herbrych, *Finite-temperature dynamics of quantum spin chains*: doctoral dissertation, Ljubljana, 2013 (mentor Peter Prelovšek).
3. Anže Lošdorfer Božič, *Interactions & geometry of self-assembly in virus-like particles*: doctoral dissertation, Ljubljana, 2013 (mentor Rudolf Podgornik).
4. Timon Mede, *Spontaneous breaking of gauge symmetry and supersymmetry in perturbative Grand Unified Theories*: doctoral dissertation, Ljubljana, 2013 (mentor Borut Bajc).
5. Jerneja Pavlin, *Liquid crystals as a means of introducing modern topics into teaching of physics: teaching module Liquid crystals for the highschool and university level*: doctoral dissertation, Maribor, 2013 (mentor Nataša Vaupotič; co-mentor Mojca Čepič).
6. Saša Zihelr, *Anisotropy of wood in the microwave region*: doctoral dissertation, Maribor, 2013 (mentor Mojca Čepič; co-mentor Jurij Bajc).
7. Matej Krajnc, *Mechanical model of simple epithelial tissue*: master's thesis, Ljubljana, 2013 (mentor Primož Zihelr).
8. Maruša Vitek, *Change of form of phospholipid vesicles due to lipopolisacharid inclusion*: master's thesis, Ljubljana, 2013 (mentor Saša Svetina; co-mentor Mojca Mally).

DEPARTMENT OF LOW AND MEDIUM ENERGY PHYSICS

F-2

The Department of Low and Medium Energy Physics is active in research in the field of atomic physics (low-energy physics) and nuclear physics (medium-energy physics). The acquired knowledge is applied for monitoring the ionizing radiation in the environment, as well as for interdisciplinary research with particle and photon beams. The Tandem Ion Accelerator at the department is one of the largest research facilities in the country. The department invested considerable efforts in the development of its own research instrumentation to enable a two-direction experimental research process: researchers from the department are performing research on large accelerator facilities abroad, and researchers from the European research area are accessing the instrumentation at the JSI ion accelerator in the frame of Transnational Access Program within the EU's 7FP.



Head:

Asst. Prof. Primož Pelicon

Within the A1 Collaboration of the MAMI facility (Mainz, Germany) we have completed the first set of measurements on the elastic scattering of electrons on protons, in which the initial-state radiation (ISR) method is used to access the range of momentum transfers otherwise unreachable in a standard spectrometer configuration. The main goal of the experiment is a determination of the elastic (electric and magnetic) form factors of the proton at momentum transfers below approximately 0.01 GeV², thereby opening a way to the determination of the mean value of the proton radius, where the discrepancy between the values extracted from electron scattering and those determined in Lamb-shift measurements in muonic atoms remains unresolved. We have also continued to perform test measurements to search for dark photons, i.e., the hypothetical particle that couples ordinary and dark matter; we have developed several versions of target cells and tested them in beam environments in order to find the optimal model to be used in production measurements. We have finished the data-acquisition period for the virtual Compton scattering by measuring the only remaining kinematic setting with 0.5 GeV². At present we are in possession of all three planned data sets at momentum transfers of 0.1, 0.2 and 0.5 GeV² that will enable us to determine the generalized polarizabilities of the proton. The preliminary results of the analysis at 0.1 GeV² are already available. The analysis of the data acquired in the recoil-polarization experiment (measurement of proton recoil polarization in neutral-pion electroproduction off protons in the region of the Roper resonance) is still on going.

In the Thomas Jefferson National Accelerator Facility (Jefferson Lab) we collaborated during the preparations for the real Compton scattering experiment at high momentum transfers, implying also large values of all the Mandelstam variables s , t and u . The main goal of the experiment is to measure the unpolarized cross-sections as functions of s and t to an accuracy of better than 10%. With such high-quality data we would be able to determine the actual power law that governs the scaling of cross-sections and thereby confirm or exclude the three proposed competing mechanisms of high-momentum scaling (perturbative QCD, approach based on generalized parton distributions and soft collinear effective theory).

In 2013 we studied electron screening in the nuclear reactions $^{58}\text{Ni}(p,\gamma)^{59}\text{Cu}$, $^{60}\text{Ni}(p,\gamma)^{61}\text{Cu}$, $^{50}\text{V}(p,n)^{50}\text{Cr}$, $^{51}\text{V}(p,\gamma)^{52}\text{Cr}$, $^{55}\text{Mn}(p,\gamma)^{56}\text{Fe}$, $^{55}\text{Mn}(p,n)^{55}\text{Fe}$, $^{113}\text{Cd}(p,n)^{113}\text{In}$, $^{115}\text{In}(p,n)^{115}\text{Sn}$ and $^{27}\text{Al}(p,\gamma)^{28}\text{Si}$. For these reactions we compared reaction cross-sections in metallic and insulating targets. Most insulating targets consisted of metallic oxides, only in the case of aluminium we additionally used a nitride target. In none of the above reactions did we observe any difference in the reaction rates between metallic and insulating targets. This contradicts the published results of a group from Bochum, Germany, which reported significant differences from measurements using two targets.

Within the Centre of Competency in Biomedical Engineering and its TOF-PET subproject, the final stages of development were performed and a provisional patent application filed to protect one of the key results for commercial exploitation. Furthermore, two different concepts for an angular-sensitive gamma camera were developed and successfully tested. Within the research on the analysis of signals from photon and particle detectors, a new approach for solid-state detector gamma-ray spectrometry at very high count rates was proposed and tested, with

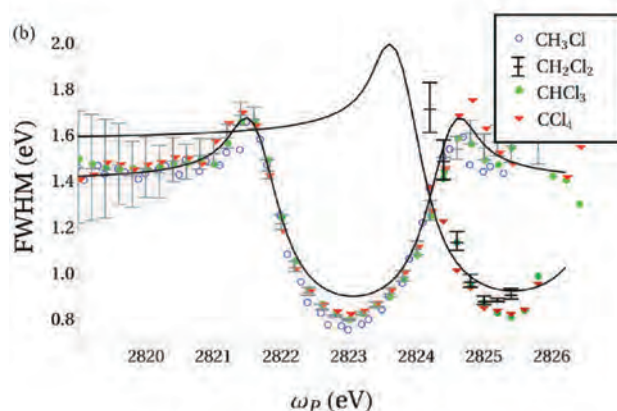


Figure 1: Widths of $K\alpha$ emission lines as a function of incoming photon energy for the 1st (lighter symbols) and 2nd (darker symbols) σ^* resonances together with the dispersions and the widths for CH_2Cl_2 generated by the fit (black lines). (R. Bohinc et al. J. Chem. Phys. 139, 134302).

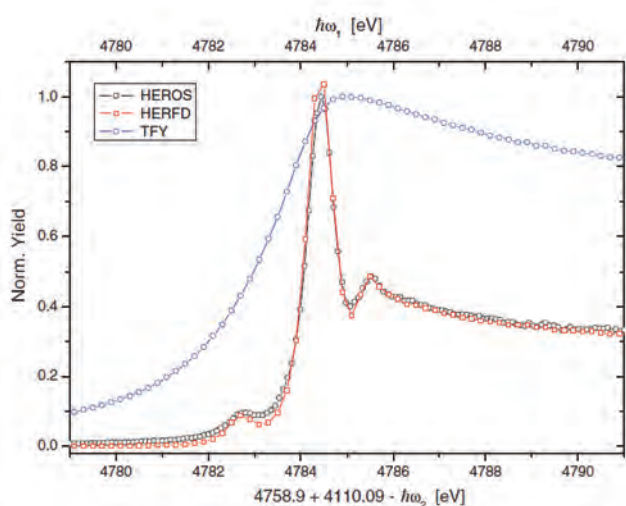


Figure 2: The HEROS L3 absorption spectrum reconstructed from the $2p_{3/2}-3d_{5/2}$ RIXS spectrum recorded at 4758.9 eV excitation energy compared with the $2p_{3/2}-3d_{5/2}$ HERFD spectrum taken at 4110.09 eV emission energy. The total fluorescence yield (TFY) spectrum is also presented for comparison (M. Kavčič et al., Phys. Rev. B 87, 075106, 2013.)

a patent granted on the subject. The first stage of the industrial project “Extending the MPPC operation into the saturation regime” was completed.

Tritium and C-14 were the main topics in the Laboratory for Liquid Scintillation Spectrometry. The determination of tritium in different types of environmental waters for the purposes of dating and hydrological studies was upgraded with a metrological approach in a bilateral cooperation with Romanian colleagues. A comparison study of methods and scintillation cocktails for a determination of tritium in urine was performed and different approaches to handling spectra with a high level of quench were tested. A direct method for the determination of the bio components’ content in fuels was improved and its range was broadened up to 100%.

The laboratory for radiological measurement systems and radioactivity measurements conducted an extensive program of radiological monitoring, including the radiological monitoring of the living environment in Slovenia, radiological monitoring of fodder in Slovenia, regular off-site radiological monitoring around Krško Nuclear Power Plant (NPP), independent radiological monitoring of the NPP, environmental monitoring around the central radioactive waste repository in Brinje, monitoring of the radioactivity in drinking water. In addition, work at the department included certified calibrations of the radiation gauges and TLD measurements of the personal and environmental doses. The laboratories active in the radiological monitoring are certified according to the ISO 17025 standard.

In the frame of the project FP7-Fission-2012 “Innovative integrative tools and platforms to be prepared for radiological emergencies and post-accident response in Europe”, the task “Table-top exercise on monitoring a large-scale cross-border contamination”, was organised in the period Dec. 11-12, with participants from 15 EU member states. In 2013, the department continued the collaboration with Metrology Institute of the Republic of Slovenia (MIRS) as the holders of radiological ethalon in the frame of European Metrology Research Programme (EMRP). The department is actively involved in the projects “MetroMetal: Ionising radiation metrology for the metallurgical industry”, “MetroRWM: Metrology for Radioactive Waste Management” and “MetroNORM: Metrology for processing materials with high natural radioactivity”. The department runs a radiological mobile unit, which performed its regular and in-field preparedness trainings around the Nuclear Power Plant Krško. In addition, it executed a demonstration of in-field action in collaboration with Administration of the Republic of Slovenia for Civil Protection and Disaster Relief.

In the beginning of 2013 we performed one of the first measurements at the new free-electron laser Fermi (Trieste). Through an analysis of the experimental results we demonstrated for the first time the two-photon resonant excitation processes for doubly excited states of helium by the detection of metastable atom decay products. Due to its seeded mode of operation, Fermi is momentarily the only (quasi)monochromatic source of extremely intense light in the VUV energy region. After we submitted the results of our analysis of the avoided crossing experiments for singly excited states of helium in a homogeneous electric field, noting the effects in the metastable yield due to the unwanted presence of the magnetic field we have proposed and conducted another experiment at the Gasphase@Elettra beamline under the controlled presence of both the electric and magnetic field. For this purpose we built a compact “Helmholtz capacitor” that allows the setting of specific field configuration with respect to the polarization of the incoming light as well as the attenuation of unwanted field components in the target region.

We achieved a better resolution with respect to the variation of the field magnitude and the results represent the first accurate systematic study of the helium LS coupled manifold of states interacting with a homogeneous electric and magnetic field. In 2013 we collaborated strongly with French researchers from the LCPMR institute (Paris). We published a comparative study of the two core-hole decay of carbon in the molecular series C₂H₂, C₂H₄ in C₂H₆ to confirm the old thesis about the larger chemical sensitivity of the near-edge measurements for two core-holes situated at different atoms in the molecule (Phys. Rev. Lett. 110, 163001). In autumn 2013 we participated in first magnetic bottle experiments involving a combination of C K and Cl L hole in CCl₄. We also participated at the experiment at Soleil to measure Auger spectra upon the resonant excitation of the Cl K orbital in chloromethane. In the field of molecular physics we published our first, theoretically rooted study about the dissociation of chloromethanes upon the excitation of the s* resonance from the Cl K shell observed with high-

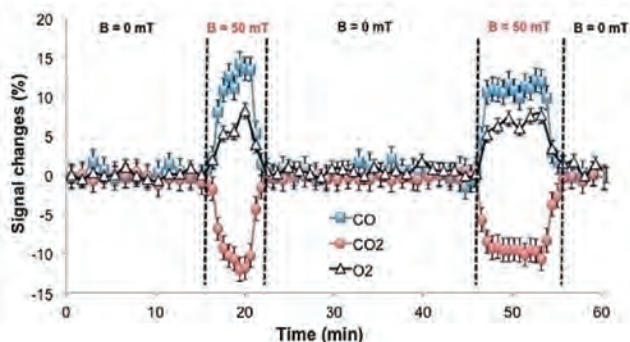


Figure 3: Relative changes in CO oxidation over Pt on Co in the presence and absence of a magnetic field at 120°C. The gas flow composition is 1% CO and 2% O₂ in Ar (total flow 30 mL/min). (J. Sa et al., Nanoscale 5, 8462, 2013).

resolution x-ray spectroscopy (J. Chem. Phys. 139, 134302). At the end of 2013 we entered the COST action CM1204: XUV/X-ray light and fast ions for fast chemistry (XLIC).

In 2013, we performed three experimental projects at the ID26 beamline of the ESRF synchrotron employing high-resolution x-ray spectroscopy. In collaboration with the University of Leuven we performed in-situ time-resolved RIXS measurements of cationic Ag clusters in zeolites during their x-ray induced formation. Using a wavelength-dispersive spectrometer and combining separate points on the homogeneous target we were able to record full L3M5 Ag RIXS maps with a 1-sec time resolution. These measurements will enable us to analyse the formation process and understand the electronic properties of the emissive Ag clusters. In the second project, which was performed in collaboration with the University of Helsinki, we have used RIXS spectroscopy at the sulphur K edge to study the local electronic structure and properties of solutions of sulphuric acid in water. These measurements will yield valuable information on the hydration of sulphuric acid on the molecular level, which plays a key role in atmospheric aerosol formation. Within the third project we performed preliminary S K edge RIXS measurements on several polysulfide samples, which are present within LiS batteries, and also three samples of LiS battery cathode material during different stages of the discharging cycle. The samples were prepared by our colleagues from the Institute of Chemistry. The measurements confirmed the high potential of RIXS spectroscopy to perform the chemical speciation of S in Li batteries and probe the S redox chemistry during the battery-charging cycle. In the field of gas-phase RIXS studies we have published in 2013 the results of the L3M5 RIXS measurements on Xe recorded at a fixed off-resonant excitation energy (Phys. Rev. B 87, 075106). The Xe example is used to present a novel method suitable for the measurement of a high-energy resolved absorption spectrum upon target excitation with an intense monochromatic pulse of x-ray light. Using a dispersive-type emission spectrometer, the scanning is completely avoided. Such an approach enables shot-by-shot measurements and in principle allows the acquisition of a full spectrum by a single intense monochromatic x-ray pulse. We presented our work in a talk at the large biennial conference ICPEACXXVIII in Langzhou, China. Together with research colleagues from the Paul Scherrer Institute we have published the results of in-situ L3M5 RIXS experiments on non-magnetic Pt catalysts, supported on carbon-coated magnetic Co nanoparticles. The measurements revealed the change of the Pt electronic structure induced by an external magnetic field. Consequently, this changed the Pt catalytic performance and enabled the catalytic control by means of an external magnetic field (Nanoscale 5, 8462). In the field of high-resolution PIXE spectroscopy employing proton beam we have published the results of K β spectra of chlorine standards and several fine fraction aerosol samples. The measured K β spectra exhibited pronounced chemical effects, which were used to identify the chemical state of Cl in aerosol samples, demonstrating the feasibility of the high-resolution PIXE method for the chemical speciation of Cl in aerosols (Spectrochimica Acta Part B 79–80, 58).

The material properties were studied with measurements of magnetic and electric hyperfine fields using Mössbauer spectroscopy. The research was focused on cathode materials for lithium batteries, which were studied at the synchrotron facilities Petra in Hamburg and APS in Chicago. The sample structure was revealed by X-ray diffraction techniques, neutron diffraction, Mössbauer spectroscopy using ^{57}Fe isotope and NMR spectroscopy on ^6Li . Based on this results we presented a model “1Fe 2Li” on the cation distribution in LiFeBO_3 .

The x-ray absorption spectroscopy research group has gained access to three beamlines (ID21, BM23 and XAFS) at ESRF (Grenoble) and Elettra (Trst) synchrotron where six experiments were performed in 2013. In collaboration with the Centre of excellence CO NOT a series of in-situ experiments were performed with XANES and EXAFS on Li-sulphur (Li_2S_x) cathode materials for batteries with a high energy density. The XAS spectra were recorded during the reduction and oxidation of materials with C/15 dynamics. They register the change of valence of Mn and Fe, and the formation of Li_2S_x compounds during the processes, providing the key information on the battery dynamics and opening the way to optimization of the synthesis of the material with maximum capacity. The results are presented in a paper, accepted for the publication end of 2013 and in talks on international conferences and foreign universities. We continued a long-term project, in collaboration with the Institute of Chemistry, which involves XAS measurements on the catalytic mesoporous molecular sieves doped with Ca, Cr, Mn, Fe, Ni and

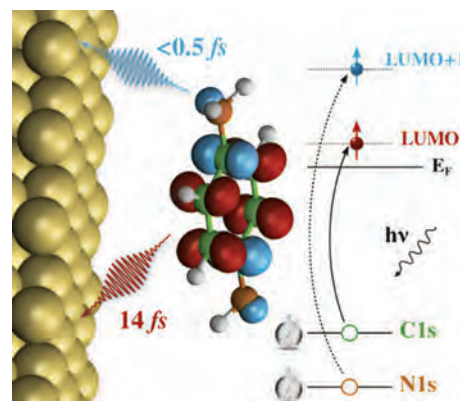


Figure 4: Core-hole clock spectroscopy can be used to measure charge transfer through non-covalent interactions. For model system of 1,4-Benzenediamine molecules on a gold surface the electron transfer across the Au-donor-acceptor bond occurs in less than 500 as (G. Kladnik et al., J. Phys. Chem. C 2013, 117, 16477).

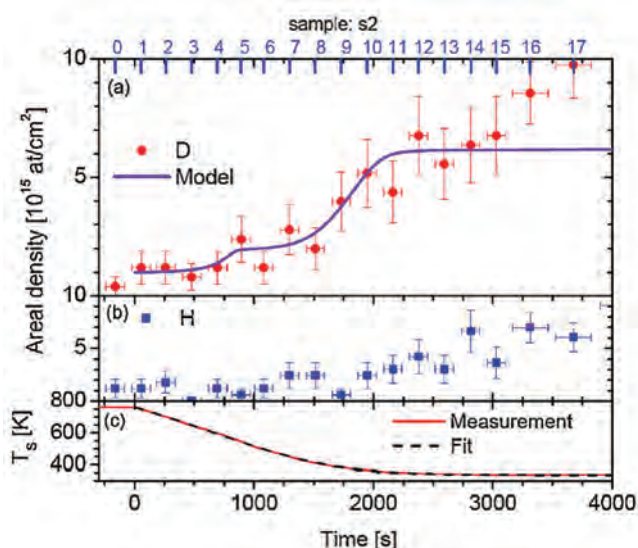


Figure 5: Thermo-adsorption of deuterium on polycrystalline tungsten sample. (a) The experimental surface deuterium areal density is shown as dots during sample cooling and exposure to the atomic deuterium beam. The modelled D areal density is shown as a line. (b) Experimental H areal density variation during D atom exposure. (c) Temperature decrease and its polynomial fit. (Markelj et al., Appl. Surf. Sci. 282, 478, 2013).

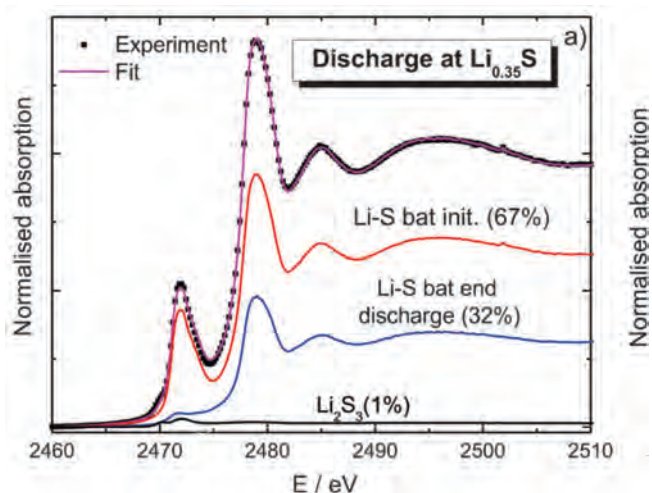


Figure 6: Sulphur K-edge XANES spectra of the Li-S battery operated in operando mode: a) in intermediate state at nominal composition $Li_{0.35}S$. Solid squares, experiment; magenta line, best fit with linear combination of reference XANES profiles. (Patel et al., accepted for publ. Chem. Phys. Chem.)

Cu, containing also organic building units on CuPd catalysts. The valence of dopants and their atomic neighbourhood is determined, to elucidate their catalytic properties. The materials aim at commercial applications such as molecular sieves and separators, adsorbents and ion traps, as well as solid heterogeneous catalysts sensitive to the molecular shape. One paper from this research topic was accepted for publication in 2013. In collaboration with Biotechnical Faculty of University of Ljubljana we performed four series of XAS experiments to determine the distribution of pollutant elements (Se, Hg, Cd, Zn, Ni, Cr) and essential elements (Zn, Cr, Fe) in the cells of hyper-accumulating plants (Plant, cell and environment 60, 2013). We published the analysis of Cd binding at the cellular and tissue levels (Plant and soil 370, 125) and the analysis of the pattern of iron distribution in maternal and filial tissues in wheat grains (Journal of Experimental Botany 64, 3249). A submicron monochromatic x-ray beam with a lateral resolution of 0.3 micrometre was used. The distribution of sulphur, chlorine and zinc was scanned simultaneously, to reveal correlations between the elements. The transport of the metal from the roots to stems, leaves and other tissues was elucidated, together with the molecular and cellular mechanisms which induce the tolerance to the noxious metal cations. About this research we published a book chapter (Phytotechnologies: remediation of the environmental contaminants. Boca Raton (FL): Taylor & Francis, cop. 2013, 443).

In collaboration with the Laboratory for material research of the University of Nova Gorica we published a paper with high impact in Chemistry of Materials about cation order-disorder transition in Fe-doped $6H-BaTiO_3$ for dilute room-temperature ferromagnetism (Chemistry of Materials, 25, 3544).

Work within the EU's fusion development program in 2013 was focused on the three priority supported EFDA tasks in collaboration with INFLPR, Bucharest, Romania, IPP, Garching, Germany, and PIIM, Univ. Aix-Marseille, France. For all these studies the Nuclear Reaction Analysis (NRA) method was used for deuterium depth profiling in materials by using a high-energy $3He$ ion beam produced by a 2MV tandem accelerator at MIC. For this purpose protons from the nuclear reaction $D(3He,p)4He$ are detected. In-situ NRA studies were performed during the thermal desorption of D from samples with D co-deposited or implanted or during D uptake on samples initially D-free but subjected to a D-atom beam (Applied Surface Science 282, 478). The studied materials were thin layers of various combinations of W, C and Al, as well as tungsten damaged by high-energy ions to simulate neutron damage (Journal of Nuclear Materials, 438, S1027). Due to the importance of this issue, IAEA has initiated in 2013 a CRP on this subject and invited us to participate. The upgrading of our vibrational spectrometer for hydrogen molecules continued. In the field of the low-energy electron-molecule collisions we worked in collaboration with The Open University, Milton Keynes, UK, on an experimental determination of anion production from acetylene (C_2H_2) using 0-90 eV electrons. By evaluating the case of a Titan atmosphere we have shown the importance of the contribution of dipolar dissociation to the total anion production in planetary ionospheres (paper in press in Physical Chemistry and Chemical Physics).

Within our collaboration at the ALOISA beamline of Elettra synchrotron (Lab. IOM/CNR), we investigated the electronic properties of organic-inorganic and hetero-organic interfaces. Within our studies of carrier transport over empty molecular orbitals in adsorbed aromatic molecules we succeeded to map the preferred pathways of ultra-fast carrier transport from organic molecules to the underlying substrate and to relate them to a specific type of molecular bonding. With the use of X-ray resonant spectroscopy we studied a model aromatic system, 1,4-benzenediamine molecules bound on a Au surface through an Au-N donor-acceptor bond, as these are known to provide a pathway for electronic conduction in molecular devices. We show that charge delocalization across the donor-acceptor bond occurs in less than 500 as. Furthermore, the Au-N bond also enhances delocalization to the substrate from the neighbouring carbon sites, demonstrating that fast charge transfer across a metal-organic interface does not require a covalently bonded system (J. Phys. Chem. C 117, 16477). Shape-complementarity of donor (D) and acceptor (A) molecules drives the hetero-organic self-assembly of photovoltaic elements into an extended interface with a ball-and-socket structural motif, which increases both the active volume and exciton dissociation rates to improve the efficiency of organic solar cells. Using core hole clock (CHC)

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Figure 7: Interface of PDZ-01 XRF analyser, developed at the department (P. Kump and Z. Rupnik).

X-ray spectroscopy and density functional theory (DFT), we compare the electronic coupling, and charge-transfer rates at the interface between the C60 acceptors and the flat- or contorted-hexabenzocorone (HBC) donors. This work provides fundamental mechanistic insights on the improved efficiency of organic photovoltaic devices that incorporate these concave/convex D/A materials (Advanced Energy Materials, 3, 894)

In the tandem accelerator laboratory of JSI, efforts were invested into the successful operation of a new, multi-cusp ion source, acquired in the frame of Large Scientific Equipment Package No. 14. After its installation, work was dedicated to the tuning of the ion source to the requirements of the accelerator. Work was successfully accomplished. We measured the normalized brightness of the high-energy proton beam with a two-slit system and achieved the value of 14, by far the highest value ever reported on tandem accelerators. Earlier reported values did not exceed values of 4 (Pelicon et al., submitted to NIM B). With such proton beam characteristics, we are able to lower the object slit size and the acceptance angle of the quadrupole lens and correspondingly achieve a much better lateral resolution in applications with high-energy focused proton beams. The micro-PIXE method is now operating with the available lateral resolution of 800 nm. In combination with the frozen hydrated tissue-handling technology, developed in the last three years, we are able to provide top experimental conditions for the quantitative elemental mapping of biological tissue. Together with external users, several papers were published, including work on wheat (Singh et al, Jour. Exp. Bot. 2013, Pongrac et al, Jour.Roy.Soc.Int. 2013) and tartary buckwheat (Pongrac in sod., Food Res. Int. 2013). Recent work in the field of nanotoxicology resulted in a paper on the fate of cobalt after the insertion of CoFe2O4 nanoparticles in organisms (Novak et al, Env. Sci. Tech, 2013). In 2013, several researchers expressed their interest to apply micro-PIXE to study processes in brains. In collaboration with Carla Iochims and Paulo Jobim from "Universidade Federal do Rio Grande do Sul", Porto Alegre, Brazil, we measured elemental distributions in rat brain tissue. Aleksandra Wandzilak from AGH University of Science and Technology, Krakow, Poland, measured the elemental distributions in human brain-tumour tissue. Important progress was achieved in the development of the MeV SIMS spectrometry, where the desorption of large unfragmented molecular ions is induced by high-energy heavy ion impact. The acquisition was developed at the field-programmable gate array (FPGA) platform, which enables multi-hit acquisition and molecular mapping. A mass resolution of 300 was achieved using a home-built Time-Of-Flight (TOF) telescope and the required steps toward the mass resolution of 1000 were indicated. We continue to provide beamtime to the researchers from the European research area in the frame of Transnational access (TNA) programme of the 7th FP EU project SPIRIT (www.spirit-ion.eu). Magali Schnell-Ramos from the University of Udine, Italy, studied iron-enrichment effects in the wheat species durum using micro-PIXE. We measured quantitative elemental maps on the cross-sections of the wheat grains with micro-PIXE. Camille Larue from Ruhr-Universität Bochum and Hiram Castillo-Mitchell from ESRF, Grenoble, applied micro-PIXE for studies of zinc and iron homeostasis in the plant *Arabidopsis thaliana*. With the tissue-preparation assistance by the colleagues from Biotechnical Faculty, University of Ljubljana, they measured elemental maps with micro-PIXE on frozen hydrated plant tissue. This is the first TNA project at JSI tandem accelerator done by recently developed frozen hydrated tissue technology. Within archaeometric research we studied glass and precious stones using in-air PIXE spectroscopy and complementary techniques. The emeralds from the Slovenian archaeological sites were analysed. This measurement together with mineralogical investigation showed emerald provenance in Egypt, though a small fraction of emeralds may originate from Afghanistan or some other sites in Egypt as well. In the same way we analysed the garnets, which are compositional part of the jewellery from the Migration Period. We confirmed the garnet provenance in South India and Sri Lanka, but we did not find any garnets from the European sites, which are typically applied on objects from the 7th c. AD. The explanation may be sought in the political changes in the territory of the present Slovenia, induced by Avaric and Slavic incursions in the 7th c. The glass analysis involved samples from Albania and the site Tonovcov grad in Slovenia. The glass from Albania showed several groups that could be related with different sources of raw materials. This finding supports the recent thesis that the glass from the Imperial period was produced in different places within Europe, but the production concentrated in the area of the present Palestine in Late Antiquity. Two types of late Roman glass were recognized in the inventory from Tonovcov grad, similar to the glass composition in Italy and eastern Mediterranean, but not in Western Europe.

Laboratory for x-ray fluorescence analysis applied the X-ray Florescence (EDXRF) method to analyse soil, plant samples and thin film-covered pharmaceutical pellets. EDXRF analysis was used to determine the mineral contents of P, S, Mn, Fe, and Zn for 150 sorts of Slovenian wheat. The concentration values accessed will be used for the further

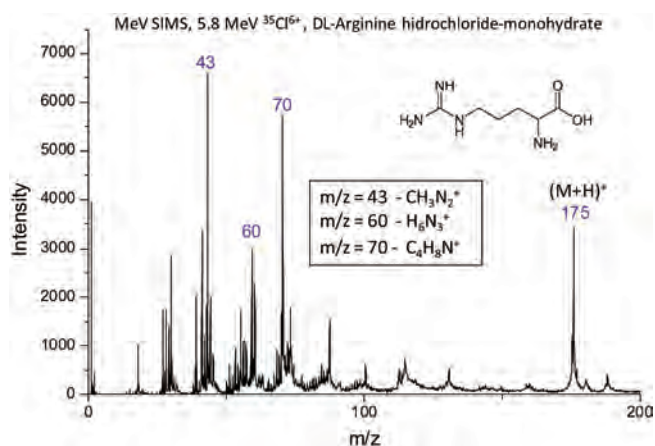


Figure 8: In 2013, we achieved a significant progress in development of molecular imaging by MeV SIMS. Home-built Time-Of-Flight spectrometer for MeV SIMS was calibrated and imaging implemented. Graph shows mass calibration spectrum measured on arginine by excitation of 5.8 MeV chlorine ions (Jeromel et al., accepted for publication in NIM B).

XANES analysis with the synchrotron micro-beam for the purpose of studying the bioavailability of these essential nutrients. The EDXRF analysis was used to study museum artefacts, mainly weapons and armour. A method for fast identification of plastic materials was developed based on measurements of the coherent and incoherent scattering of X-rays in an EDXRF experiment. In collaboration with members of the Biotechnical Faculty we participated in experiments on the TwinMic beamline of the synchrotron Elettra in Trieste and the beamline ID 21 of synchrotron ESRF in Grenoble, where the in-house procedures and software for the quantification of XRF results was developed and used. Dr. Peter Kump constructed a prototype of the portable EDXRF analyzer.

Organization of conferences, congresses and meetings

1. Monitoring a large scale cross border contamination in the aftermath of a nuclear accident, Ljubljana, 11.-12. 2013

Patent granted

1. Silvan Bucik, Borut Baričević, Borut Repič, Matjaž Vencelj, A method of analog and digital signal processing of information contained in pulses, and a device for achieving the same, SI23959 (A), Urad RS za intelektualno lastnino, 28.6.2013.

INTERNATIONAL PROJECTS

- | | |
|---|--|
| 1. Services
Foreign buyers
Branko Vodenik, M. Sc. | Euramet e.V.
Branko Vodenik, M. Sc. |
| 2. Calibrations
Foreign buyers
Matjaž Mihelič, M. Sc. | 15. MetroNORM; Metrology for Processing Materials with High Natural Radioactivity
Euramet e.V.
Branko Vodenik, M. Sc. |
| 3. TLD dosimetry
Foreign buyers
Boštjan Črnič | 16. Convention de mise a disposition; Letter N/REF: NS/MD/CONV/04FRE2681JS/2004 dtd. 8. 9. 2004
Ecole Normale Superieure
Dr. Iztok Čadež |
| 4. Provision of Testing Services for Filter Media used in IMS Radionuclide Stations
CTBTO Preparatory Commission
Dr. Benjamin Zorko | 17. Determination of Trace Elements in Lu Foil by k α -INAA and XRF
Institute for Reference Materials and Measurements
Dr. Peter Kump |
| 5. 7FP - SPIRIT; Support of Public and Industrial Research Using Ion Beam Technology
European Commission
Asst. Prof. Primož Pelicon | 18. COST CM1204: XUV/X-ray Light and Fast Ions for Ultrafast Chemistry (XLIC)
COST Office
Asst. Prof. Matjaž Žitnik |
| 6. 7FP - SPRITE; Supporting Postgraduate Research with Internships in Industry and Training Excellence
European Commission
Asst. Prof. Matjaž Kavčič | 19. IAEA Fellowship for Ms Aleksandra Wandzilak, POL/13005
IAEA - International Atomic Energy Agency
Asst. Prof. Primož Pelicon |
| 7. 7FP - PREPARE; Innovative Integrative Tools and Platforms to be Prepared for Radiological Emergencies and Post-accident Response in Europe
European Commission
Dr. Benjamin Zorko | 20. Hydrogen Retention in Self-damaged and He Irradiated Tungsten Alloys in Fusion Devices; Plasma-Wall Interaction for Irradiated Tungsten and Tungsten Alloys in Fusion Devices
IAEA - International Atomic Energy Agency
Dr. Sabina Markelj |
| 8. 7FP - EURATOM; Application of Ion Beam Analytical Methods to the Studies of Plasma Wall Interaction Studies - 1.4.3.-FU; 3211-08-000102, FU07-CT-2007-00065
Location
Ministry of Education, Science and Sport
Asst. Prof. Primož Pelicon | 21. Preparation and Analysis of Reference Materials
Iarma Limited
Dr. Jasmina Kožar Logar |
| 9. 7FP - EURATOM-MHEST; 1.4.1.-FU, Processes with Neutral Hydrogen Atoms and Molecules
Ministry of Education, Science and Sport
Dr. Sabina Markelj | 22. Different Analyses
Foreign buyers
Dr. Jasmina Kožar Logar |
| 10. 7FP - EURATOM-MHEST, WP13-IPH-A03-P1-01/MESCS/PS, Atomic and Low-Energy Hydrogenic Plasma Interaction with Damaged Tungsten
Ministry of Education, Science and Sport
Dr. Sabina Markelj | 23. Dynamics at Nanoscale
Slovenian Research Agency
Asst. Prof. Matjaž Žitnik |
| 11. 7FP - EURATOM-MHEST, WP13-IPH-A03-P2-01/MESCS/PS, D Re-Adsorption/Re-Saturation of W Surfaces Subject to Helium RF - Discharge as a Fuel Removal Technique
Ministry of Education, Science and Sport
Dr. Sabina Markelj | 24. LSC Methods for Determination of H-3 and C-14 in Environmental Samples
Slovenian Research Agency
Dr. Jasmina Kožar Logar |
| 12. 7FP - EURATOM-MHEST; WP13-IPH-A01-P3-01/MESCS/PS, Analyses of the Deuterium Trapping in Mixed Materials and Analyses of Mixed Materials Films Relevant to ITER by Ion Beam Analytical Methods
Jožef Stefan Institute
Asst. Prof. Primož Pelicon | 25. Study of Deeply Virtual Compton Scattering
Slovenian Research Agency
Prof. Simon Širca |
| 13. MetroRWM; Metrology for Radioactive Waste Management
Euramet e.V.
Branko Vodenik, M. Sc. | 26. Virtual Compton Scattering on the Nucleon
Slovenian Research Agency
Prof. Simon Širca |
| 14. MetroMetal - Ionising Radiation Metrology for the Metallurgical Industry | 27. Measurements and Control of Deuterium in Fusion Material
Slovenian Research Agency
Asst. Prof. Primož Pelicon |
| | 28. Co-financing of the Promotion of Science
European Commission
Asst. Prof. Primož Pelicon |

RESEARCH PROGRAMS

1. Archaeological and Archaeometric Research of Portable Archaeological Heritage
Prof. Žiga Šmit
2. Object and Prestige; taste, status, power (Researches of the material culture in Slovenia)
Dr. Marijan Nečemer
3. Structure of Hadronic Systems
Prof. Simon Širca
4. Studies of Atoms, Molecules and Structures by Photons and Particles
Asst. Prof. Matjaž Žitnik

R&D GRANTS AND CONTRACTS

1. Investigation of Plant Ion Homeostasis Using Elemental Imaging by Laser Ablation - Inductively Coupled Plasma Mass Spectrometry (Basic Research Project)
Asst. Prof. Primož Pelicon
2. Research of the Ionome of Selected Mycorrhizal Plants
Asst. Prof. Primož Pelicon
3. Sustainable Land Use in Relation to Soil and Crop Quality
Asst. Prof. Primož Pelicon
4. Archaeologies of Hunter-Gatherers, Farmers and Metallurgists: Cultures, Populations, Palaeoeconomies and Climate
Dr. Marijan Nečemer
5. Nanostructured Cathodes for Lithium Sulphur Batteries
Dr. Darko Hanzel
6. Groundwater Age Determination in Deep Aquifers of Slovenia
Dr. Jasmina Kožar Logar
7. Complex Hyperspectral System for Automatic Analysis and Control of Pharmaceutical Pellet Coating Processes
Dr. Peter Kump
8. The Use of Specific Methods for Determination and Prevention of Adulteration of Milk and Dairy Products
Dr. Marijan Nečemer

9. Center of Competence BioMedical Engineering: CC BME
Dr. Matjaž Vencelj
10. EMRP - MetroRWM; Metrology for Radioactive Waste Management
Branko Vodenik, M. Sc.
11. EMRP - MetroMetal; Ionising Radiation Metrology for the Metallurgical Industry
Branko Vodenik, M. Sc.

NEW CONTRACTS

1. Monitoring of Radioactivity in the Living Environment in Slovenia 2013-2014
Ministry of Agriculture and the Environment
Dr. Benjamin Zorko
2. Extension of MPPC Performance into the Saturation Regime
Beyond Devices, d. o. o.
Dr. Matjaž Vencelj
3. Support to Research Work of Industrial Young Researcher Romana Kristof in 2013
Ames, d. o. o.
Dr. Jasmina Kožar Logar
4. Off-site Radiological Monitoring of NPP Krško 2011-2013
Krško Nuclear Power Plant
Doc. dr. Matej Lipoglavšek
5. Annex No. 7 to the contract on performing activities and fulfillment of obligations of holder of national standard in the field of ionising radiation
Ministry of Economic Development and Technology
Mag. Denis Glavič Cindro
6. Ecology laboratory with mobile unit 2013
Ministry of Defence
Asst. Prof. Matej Lipoglavšek

VISITORS FROM ABROAD

1. Dr. Margarita Herranz Soler and Dr. Raquel Iodeta, ETSI, Bilbao, Spain, 13.-17. 1. 2013
2. Antti Kettunen, Oulu University, Oulu, Finland, 6. 5.-17. 6. 2013
3. Assoc. Prof. Osman Şahin, Asst. Prof. Bünyamin, Asst. Prof. Sinan Yaşar, Mustafa Kemal University, Hatay, Turkey, 3.-8. 6. 2013
4. Martine Schulte-Borchers, ETH, Zürich, Switzerland, 4.-6. 6. 2013
5. Dr. Camille Larue, Ruhr-University Bochum, Bochum, Germany, 8.-12. 7. 2013
6. Dr. Hiram Castillo-Michel, ESRF, Grenoble, France, 8.-12. 7. 2013
7. Dr. Carmen Varlam, Dr. Ionut Faurescu, INC-DTCH-ICSI, Ramnicu Valcea, Romania, 25. 8.-7. 9. 2013
8. Dr. Dimosthenis Sokaras, SSRL, Menlo Park, USA, 8.-12. 9. 2013
9. Dr. Helene Fonvieille, Loup Correa, CNRS, LPC Clermont-Ferrand, Clermont-Ferrand, France, 15.-20. 9. 2013
10. Aleksandra Wandzilak, Faculty of Physics and Applied Computer Science - AGH, Kraków, Poland, 23. 9.-22. 12. 2013
11. Dr. Dolors Company, University of Girona, Girona, Spain, 29. 9.-6. 10. 2013
12. Dr. Carla Iochims, UFRGS, Porto Alegre, Brazil, 4.-14. 10. 2013
13. Dr. Paulo Jobim, UFRGS, Porto Alegre, Brazil, 4.-25. 10. 2013
14. Abdulghani Shakhshiro, IARMA Limited, Thurso, UK, 24.-30. 10. 2013
15. Marlina Harnisch, Katrin Tanzer, IPP, Innsbruck, Austria, 4.-15. 11. 2013
16. Prof. Claudio Spitaleri, INFN and LNS, Catania, Italy, 5.-7. 11. 2013
17. Giuliano Mini, Giovanni Burgada, CAEN SpA, Viareggio Lucca, Italy, 12.-13. 11. 2013
18. Lukaš Skála, ENVINET as, Trebic, Czech Republic, 12.-13. 11. 2013
19. Giscard Honore Sonkwa Monthe, University of Yaoundé, Yaoundé, Cameroon, 1.-23. 12. 2013
20. Dr. Régis Bisson, Aix Marseille University, Marseille, France, 17.-20. 12. 2013

STAFF

Researchers

1. Prof. Iztok Arčon*
2. Dr. Klemen Bučar
3. Prof. Dean Cvetko*
4. Denis Glavič Cindro, M. Sc.
5. Dr. Darko Hanzel
6. Asst. Prof. Matjaž Kavčič
7. Dr. Jasmina Kožar Logar
8. Dr. Peter Kump
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39. Mirko Ribič, B. Sc.

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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. A1 Collaboration, Patrick Achenbach *et al.*, "Overview of the electromagnetic production of strange mesons at MAMI", V: XI International Conference on Hypernuclear and Strange Particle Physics, HYP2012, Barcelona, Spain, 1-5 October 2012, *Nucl. Phys. A*, vol. 914, pp. 41-50, 2013.
2. Robin Amisse, Stéphane Hamelet, Darko Hanžel, Matthieu Courty, Robert Dominko, Christian Masquelier, "Nonstoichiometry in $\text{LiFe}_{0.5}\text{Mn}_{0.5}\text{PO}_4$: structural and electrochemical properties", *J. Electrochem. Soc.*, vol. 160, no. 9, pp. A1446-A1450, 2013.
3. Rok Bohinc, Matjaž Žitnik, Klemen Bučar, Matjaž Kavčič, L. Journal, R. Guillemin, T. Marchenko, M. Simon, W. Cao, "Dissociation of chloromethanes upon resonant σ^* excitation studied by x-ray scattering", *J. chem. phys.*, vol. 139, no. 13, pp. 134302-1-134302-11, 2013.
4. Hermann Bothe, Katarina Vogel-Mikuš, Paula Pongrac, Matevž Likar, Neva Štepic, Primož Pelicon, Primož Vavpetič, Luka Jeromel, Marjana Regvar, "Metallophyte status of violets of the section Mellanium", *Chemosphere (Oxford)*, vol. 93, issue 9, pp. 1844-1855, 2013.
5. Mirela Dragomir, Iztok Arčon, Sandra Gardonio, Matjaž Valant, "Phase relations and optoelectronic characteristics in the $\text{NdVO}_4\text{-BiVO}_4$ system", *Acta mater.*, vol. 61, no. 4, pp. 1126-1135, Feb. 2013.
6. A. Esser *et al.* (45 authors), "Prospects for hypernuclear physics at Mainz: from KAOS@MAMI to PANDA@FAIR", In: XI International Conference on Hypernuclear and Strange Particle Physics, HYP2012, Barcelona, Spain, 1-5 October 2012, *Nucl. Phys. A*, vol. 914, pp. 519-529, 2013.
7. J. F. Facetti-Masulli, Franklin Flores, Peter Kump, "Geochemical studies and elemental contaminants in the Bay of the city of Asunción", *J. chem. eng.*, vol. 7, pp. 1060-1067, 2013.
8. Helena Fajfar, Žiga Šmit, Mateja Kos, "PIXE-PIGE analysis of coloured historic glass", *Glass Technol.*, vol. 54, no. 6, pp. 218-255, 2013.
9. Peter Fajfar, Jože Medved, Grega Klančnik, Tomaž Lazar, Marijan Nečemer, Primož Mrvar, "Characterization of a Messer - the late-Medieval single-edged sword of Central Europe", *Mater. charact.*, vol. 86, pp. 232-241, December 2013.
10. Jelena Gajević, Aleksandra Cvetinović, Andrej Likar, Matej Lipoglavšek, Primož Pelicon, Toni Petrovič, Alberto Sánchez Ortiz, "Electron screening in nickel", *The european physical journal. A, Hadrons and nuclei*, vol. 49, no. 6, pp. 70-1-70-7, 2013.
11. Ebrahim Gholami Hatam, Mohammad Lamehi-Rachti, Primož Vavpetič, Nataša Grlj, Primož Pelicon, "Surface topography of 1 eur. coin measured by stereo-PIXE", In: Proceedings of the 13th International Conference on Nuclear Microprobe Technology, 22-27 July 2012, Lisbon, Portugal, *Nucl. Instrum. Methods Phys. Res., Sect. B*, vol. 306, pp. 90-93, 2013.
12. Denis Glavič-Cindro, Ljudmila Benedik, Jasmina Kožar Logar, Branko Vodenik, Benjamin Zorko, "Detection of Fukushima plume within regular Slovenian environmental radioactivity surveillance", In: Proceedings of the 6th International Conference on Radionuclide Metrology - Low Level Radioactivity Measurement Techniques, 17-21 September 2013, Jeju Island, Korea, *Appl. Radiat. Isot.*, vol. 81, pp. 374-378, 2013.
13. Bojan Golli, Simon Širca, "A chiral quark model for meson electroproduction in the region of D-wave resonances", *The european physical journal. A, Hadrons and nuclei*, vol. 49, iss. 9, 11 pp., 2013.
14. V. Romero de González, A. De Lorenzi, Peter Kump, J. F. Facetti-Masulli, "Selected mineral contents in wheat from Paraguay by X-ray fluorescence", *J. chem. eng.*, vol. 6, pp. 1114-1120, 2013.
15. Matjaž Kavčič, Matjaž Žitnik, Klemen Bučar, Andrej Mihelič, Bor Marolt, J. Szlachetko, P. Glatzel, K. Kvashnina, "Hard x-ray absorption spectroscopy for pulsed sources", *Phys. rev., B, Condens. matter mater. phys.*, vol. 87, no. 7, pp. 075106-1-075106-6, 2013.
16. Zsófia Kertész, Enikő Furu, Matjaž Kavčič, "Chemical speciation of chlorine in atmospheric aerosol samples by high-resolution proton induced X-ray emission spectroscopy", *Spectrochim. acta, Part B: At. spectrosc.*, vol. 79-80, pp. 58-62, 2013.
17. Gregor Kladnik, Dean Cvetko, Arunabh Batra, Martina Dell'Angela, Albano Cossaro, Maria Kamenetska, Latha Venkataraman, Alberto Morgante, "Ultrafast charge transfer through noncovalent AuN interactions in molecular systems", *The journal of physical chemistry. C, Nanomaterials and interfaces*, vol. 117, issue 32, pp. 16477-16484, 2013.
18. Alojz Kodre, Jana Padežnik Gomilšek, Robert Hauko, Martin Šala, Iztok Arčon, "Absolute determination of the X-ray absorption coefficient of barium in the L region using a liquid absorption cell", *X-ray spectrom.*, vol. 42, iss. 2, pp. 63-67, 2013.
19. Špela Koren, Iztok Arčon, Peter Kump, Marijan Nečemer, Katarina Vogel-Mikuš, "Influence of CdCl_2 and CdSO_4 supplementation on Cd distribution and ligand environment in leaves of the Cd hyperaccumulator *Noccaea (Thlaspi) praecox*", *Plant soil*, vol. 370, no. 1/2, pp. 125-148, 2013.
20. Matjaž Korun, Branko Vodenik, Benjamin Zorko, "Evaluation of gamma-ray spectrometric results near the decision threshold", *Appl. radiat. isotopes*, vol. 73, pp. 1-8, 2013.
21. Matjaž Korun, Branko Vodenik, Benjamin Zorko, "Probability of Type-I errors in the peak analyses of gamma-ray spectra", *Appl. radiat. isotopes*, vol. 72, no. 1, pp. 58-63, 2013.
22. Matjaž Korun, Benjamin Zorko, "Reporting measurement results of activities near the natural limit: note and extension of the article Interpretation of measurement results near the detection limit in gamma-ray spectrometry using Bayesian statistics", *Accredit. qual. assur.*, vol. 18, no. 3, pp. 175-179, 2013.
23. Romana Krištof, Jasmina Kožar Logar, "Direct LSC method for measurements of biofuels in fuel", *Talanta (Oxford)*, vol. 111, pp. 183-188, 2013.
24. Albina Kržič, Žiga Šmit, Helena Fajfar, Matej Dolenc, Breda Činčuhant, Miha Jeršek, "The origin of emeralds embedded in archaeological artefacts in Slovenia", *Geologija*, knj. 56, no. 1, pp. 29-46, 2013.
25. Deyan Lesigyrski, Žiga Šmit, Boika Zlateva-Rangelova, Kristina Koseva, Ivelin Kuleff, "Characterization of the chemical composition of archaeological glass finds from South-Eastern Bulgaria using PIXE, PIGE and ICP-AES", *J. radioanal. nucl. chem.*, vol. 295, issue 3, pp. 1605-1619, 2013.
26. Andrej Likar, Nada Razpet, "Towards the Kelvin wake and beyond", *Am. j. phys.*, vol. 81, no. 4, pp. 245-252, apr. 2013.
27. Lyudmila Lyubenova, Paula Pongrac, Katarina Vogel-Mikuš, Gašper Kucek Mezek, Primož Vavpetič, Nataša Grlj, Marjana Regvar, Primož Pelicon, Peter Schröder, "The fate of arsenic, cadmium and lead in *Typha latifolia*: a case study on the applicability of micro-PIXE in plant ionomics", *J. hazard. mater.*, vol. 248/249, pp. 371-378, 2013.
28. Sabina Markelj, Olga Ogorodnikova, Primož Pelicon, Thomas Schwarz-Selinger, Iztok Čadež, "Temperature dependence of D atom adsorption on polycrystalline tungsten", *Appl. surf. sci.*, vol. 282, pp. 478-486, 2013.
29. M. Nakanov *et al.* (17 authors), "Single photon K^{-2n} and $K^{-1}K^{-1}$ double core ionization in C_2H_2 ($n=1-3$), CO, and N_2 as a potential new tool for chemical analysis", *Phys. rev. lett.*, vol. 110, issue 16, pp. 163001-1-163001-5, 2013.
30. Marijan Nečemer, Peter Kump, Primož Šket, Janez Plavec, Jože Grdadolnik, Maja Žvanut, "A novel analytical technique suitable for the identification of plastics", *Acta chim. slov.*, vol. 60, no. 3, pp. 701-705, 2013.
31. Marijan Nečemer, Tomaž Lazar, Žiga Šmit, Peter Kump, Borut Žužek, "Study of the provenance and technology of asian kris daggers by application of X-ray analytical techniques and hardness testing", *Acta chim. slov.*, vol. 60, no. 2, pp. 351-357, 2013.
32. Sara Novak, Damjana Drobne, Miha Golobič, Jernej Zupanc, Tea Romih, Alessandra Gianoncelli, Maya Petrova Kiskinova, Burkhard Kaulich, Primož Pelicon, Primož Vavpetič, Luka Jeromel, Nina Ogrinc, Darko Makovec, "Cellular internalisation of dissolved cobalt ions from ingested CoFe_2O_4 nanoparticles: in vivo experimental evidence", *Environ. sci. technol.*, vol. 47, no. 10, pp. 5400-5408, 2013.
33. P. O'Keeffe, Andrej Mihelič, Paola Bolognesi, Matjaž Žitnik, Angelica Moise, R. Richter, Lorenzo Avaldi, "Near-threshold photoelectron angular distributions from two-photon resonant ionisation of He", *New journal of physics*, vol. 15, pp. 013023-013023-19, 2013.
34. Nina Ogrinc, Primož Pelicon, Primož Vavpetič, Mitja Klemenčič, Nataša Grlj, Luka Jeromel, Sergej Tomič, Miodrag Čolić, Alfred Beran, "Quantitative assay of element mass inventories in single cell biological systems with micro-PIXE", In: Proceedings of the 13th International Conference on Nuclear Microprobe Technology, 22-27 July 2012,

- Lisbin, Portugal, *Nucl. Instrum. Methods Phys. Res., Sect. B*, vol. 306, pp. 121-124, 2013.
35. Davor Peruško, M. Čizmović, Suzana Petrović, Zdravko Siketić, Miodrag Mitrić, Primož Pelicon, Goran Dražić, Janez Kovač, Velimir Milinović, Momir Milosavljević, "Laser irradiation of nano-metric Al/Ti multilayers", *Laser phys.*, vol. 23, no. 3, pp. 036005-1-036005-7, 2013.
 36. Suzana Petrović, Bojan Radak, Davor Peruško, Primož Pelicon, Janez Kovač, Miodrag Mitrić, Biljana Gaković, Milan Trtica, "Laser-induced surface alloying in nanosized Ni/Ti multilayer structures", *Appl. surf. sci.*, vol. 264, pp. 273-279, 2013.
 37. Paula Pongrac, Ivan Kreft, Katarina Vogel-Mikuš, Marjana Regvar, Mateja Germ, Primož Vavpetič, Nataša Grlj, Luka Jeromel, Diane Eichert, Bojan Budič, Primož Pelicon, "Relevance for food sciences of quantitative spatially resolved element profile investigations in wheat (*Triticum aestivum*) grain", *Journal of the Royal Society interface*, vol. 10, no. 84, pp. 1742-5662, 2013.
 38. Paula Pongrac, Katarina Vogel-Mikuš, Luka Jeromel, Primož Vavpetič, Primož Pelicon, Burkhard Kaulich, Alessandra Gianoncelli, Diane Eichert, Marjana Regvar, Ivan Kreft, "Spatially resolved distributions of the mineral elements in the grain of tartary buckwheat (*Fagopyrum tataricum*)", *Food res. int.*, vol. 54, issue 1, pp. 125-131, 2013.
 39. Paula Pongrac *et al.* (11 avtorjev), "On the distribution and evaluation of Na, Mg and Cl in leaves of selected halophytes", *Nucl. instrum. methods phys. res., B Beam interact. mater. atoms*, vol. 306, pp. 144-149, 2013.
 40. Jacinto Sá, Jakub Szlachetko, Marcin Sikora, Matjaž Kavčič, Olga V. Safonova, Maarten Nachttegaal, "Magnetic manipulation of molecules on a non-magnetic catalytic surface", *Nanoscale*, issue 18, vol. 5, pp. 8462-8465, 2013.
 41. Theanne Schiros *et al.* (17 authors), "Donor-acceptor shape matching drives performance in photovoltaics", *Adv. energy mater.*, vol. 3, iss. 7, pp. 894-902, 2013.
 42. B. S. Schlimme *et al.* (32 authors), "Measurement of the neutron electric to magnetic form factor ratio at $Q^2 = 1.58 \text{ GeV}^2$ using the reaction ${}^3\text{He}(\bar{e}, e'n)pp$ ", *Phys. rev. lett.*, vol. 111, iss. 13, pp. 132504-1-132504-5, 2013.
 43. Sudhir P. Singh, Katarina Vogel-Mikuš, Iztok Arčon, Primož Vavpetič, Luka Jeromel, Primož Pelicon, Jitendra Kumar, R. Tuli, "Pattern of iron distribution in maternal and filial tissues in wheat grains with contrasting levels of iron", *J. Exp. Bot.*, vol. 64, no. 11, pp. 3249-3260, 2013.
 44. N. F. Sparveris *et al.* (32 authors), "Measurements of the $\gamma^*p \rightarrow \Delta$ reaction at low Q^2 ", *The european physical journal. A, Hadrons and nuclei*, vol. 49, iss. 10, 7 pp., 2013.
 45. Žiga Šmit, Tina Milavec, Helena Fajfar, Th. Rehren, J. W. Lankton, B. Gratuze, "Analysis of glass from the post-Roman settlement Tonovcov grad (Slovenia) by PIXE-PIGE and LA-ICP-MS", *Nucl. instrum. methods phys. res., B Beam interact. mater. atoms*, vol. 311, pp. 53-59, 2013.
 46. Žiga Šmit, Fatos Tartari, Frederik Stamati, Aferdita Vevecka-Priftaj, Janka Istenič, "Analysis of Roman glass from Albania by PIXEPIGE method", *Nucl. instrum. methods phys. res., B Beam interact. mater. atoms*, vol. 296, pp. 7-13, 2013.
 47. Matjaž Valant, Iztok Arčon, Iuliia Mikulska, Darja Lisjak, "Cation order-disorder transition in Fe-doped $6\text{H} - \text{BaTiO}_3$ for dilute room-temperature ferromagnetism", *Chem. mater.*, vol. 25, no. 17, pp. 3544-3550, 2013.
 48. Primož Vavpetič, Primož Pelicon, Katarina Vogel-Mikuš, Nataša Grlj, Paula Pongrac, Luka Jeromel, Nina Ogrinc, Marjana Regvar, "Micro-PIXE on thin plant tissue samples in frozen hydrated state: a novel addition to JSI nuclear microprobe", *Nucl. instrum. methods phys. res., B Beam interact. mater. atoms*, vol. 306, pp. 140-143, 2013.
 49. Jefferson Lab Hall A Collaboration, D. Wang *et al.*, "Measurements of parity-violating asymmetries in electron-deuteron scattering in the nucleon resonance region", *Phys. rev. lett.*, vol. 111, iss. 8, pp. 082501-1-082501-7, 2013.
 50. Matjaž Žitnik, Klemen Bučar, Andrej Mihelič, P. Lablanquie, F. Penet, J. Paladoux, L. Andric, Paola Bolognesi, Lorenzo Avaldi, "Inter- and intrachannel exchange interference in photoinduced Auger decay: the $KrM_{4,5} - N_{1,2,3}$ and $XeN_{4,5} - O_{1,2,3}$ cases", *Phys. rev., A*, vol. 87, no. 1, pp. 013436-013436-15, 2013.

SHORT ARTICLE

1. Matjaž Valant, Taras Kolodiaznyy, Iztok Arčon, Frederic Aguesse, Anna-Karin Axelsson, Neil McN. Alford, "Response to "Comment on "The origin of magnetism in Mn-doped SrTiO_3 """, *Adv. funct. mater.*, vol. 23, no. 18, pp. 2231-2232, maj 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Bojan Golli, Simon Širca, "Electroexcitation of the D-wave resonance", In: *Proceedings to the Mini-Workshop Looking into Hadrons, Bled, Slovenia, July 7-14, 2013*, (Blejske delavnice iz fizike, vol. 14, no. 1), Bojan Golli, ed., Mitja Rosina, ed., Simon Širca, ed., Ljubljana, DMFA - založništvo, 2012, vol. 14, no. 1, pp. 43-44, 2013.
2. Sabina Markelj, Iztok Čadež, Primož Vavpetič, Primož Pelicon, Corneliu Porosnicu, Cristian P. Lungu, "Deuterium thermal desorption from mixed layers relevant for ITER", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013*, 9 pp.
3. Sabina Markelj, Olga Ogorodnikova, Primož Pelicon, Thomas Schwarz-Selinger, Iztok Čadež, "Study of thermal hydrogen atom interaction with undamaged and self-damaged tungsten", In: *Proceedings of the 20th International Conference on Plasma-Surface Interactions in Controlled Fusion Devices, 21-25 May, 2012, Aachen, Germany*, (Journal of nuclear materials, vol. 438, suppl. 2013), Sebastijan Brezinšek, ed., Amsteram, North-Holland, 2013, vol. 438, suppl. 2013, pp. S1027-S1031.
4. Harald Merkel *et al.* (32 authors), "Searches for dark photons at the Mainz Microtron", In: *Workshop to Explore Physics Opportunities with Intense, Polarized Electron Beams at 50-300 MeV, 14-16 March 2013, Cambridge, Massachusetts, USA*, (AIP conference proceedings, 1563), Richard Milner, ed., Roger Carlini, ed., Frank Maas, ed., [Melville], American Institute of Physics, 2013, pp. 143-146.
5. A1 Collaboration, Miha Mihovilovič *et al.*, "Initial state radiation experiment at MAMI", In: *Workshop to Explore Physics Opportunities with Intense, Polarized Electron Beams at 50-300 MeV, 14-16 March 2013, Cambridge, Massachusetts, USA*, (AIP conference proceedings, 1563), Richard Milner, ed., Roger Carlini, ed., Frank Maas, ed., [Melville], American Institute of Physics, 2013, pp. 187-190.
6. B. Pégourié *et al.* (54 authors), "Deuterium inventory in Tore Supra: Coupled carbondeuterium balance", In: *Proceedings of the 20th International Conference on Plasma-Surface Interactions in Controlled Fusion Devices, 21-25 May, 2012, Aachen, Germany*, (Journal of nuclear materials, vol. 438, suppl. 2013), Sebastijan Brezinšek, ed., Amsteram, North-Holland, 2013, vol. 438, no. suppl., pp. S120-S125, 2013.
7. Branko Petrinc, Marko Šoštarič, Dinko Babić, Benjamin Zorko, "Specifičnosti interkomparacije na uzorku stijenja s otoka Jabuke", In: *Zbornik radova 9. simpozija Hrvatskog društva za zaštitu od zračenja: HDZZ - CRPA: Zagreb 2013*, Željka Knežević, ed., Marija Majer, ed., Ines Krajcar Bronić, ed., Zagreb, Hrvatsko društvo za zaštitu od zračenja, 2013, pp. 502-506.
8. Toni Petrovič, Matjaž Vencelj, Matej Lipoglavšek, Roman Novak, Deniz Savran, "Pile-up reconstruction algorithm for high count rate gamma-ray spectrometry", In: *Proceedings of the International Conference on Recent Trends in Nuclear Physics, ICRTNP 2012, 19-21 November, Barotivala, India*, (AIP conference proceedings, vol. 1524, 2013), Sushil Kumar, ed., Ashok K. Jain, ed., New York, American Institute of Physics, 2013, vol. 1524, pp. 279-282, 2013.
9. Paula Pongrac, Katarina Vogel-Mikuš, Marjana Regvar, Primož Pelicon, Primož Vavpetič, Luka Jeromel, Ivan Kreft, "Localisation of mineral elements in common and tartary buckwheat grain as revealed by multielemental and quantitative micro-PIXE", In: *The proceedings of papers*, Mateja Germ, ed., et al, Pernica, Fagopyrum - slovensko društvo za promocijo ajde, 2013, pp. 110-111.
10. Simon Širca, "Real and virtual compton scattering experiments at MAMI and Jefferson Lab", In: *Proceedings to the Mini-Workshop Looking into Hadrons, Bled, Slovenia, July 7-14, 2013*, (Blejske delavnice iz fizike, vol. 14, no. 1), Bojan Golli, ed., Mitja Rosina, ed., Simon Širca, ed., Ljubljana, DMFA - založništvo, 2012, vol. 14, no. 1, pp. 57-62, 2013.
11. Adrian Vincent, Marinka Gams Petrišič, Marijan Nečemer, Nives Ogrinc, "Fatty acid composition as a tool for determination of geographical origin and authenticity of milk and dairy products", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013*, pp. 90-96.
12. Anže Založnik, Iztok Čadež, Sabina Markelj, Vida Žigman, "Modelling hydrogen-metal surface interactions: the integral study", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013*, pp. 1406.1-1406-7.

13. Benjamin Zorko, Željka Knežević, Boštjan Črnič, Marija Majer, Sandi Gobec, Maria Ranogajec-Komor, "Intercomparison of environmental doseimeters using various TL materials and dosimetry systems", In: *Zbornik radova 9. simpozija Hrvatskog društva za zaštitu od zračenja: HDZZ - CRPA: Zagreb 2013*, Željka Knežević, ed., Marija Majer, ed., Ines Krajcar Bronić, ed., Zagreb, Hrvatsko društvo za zaštitu od zračenja, 2013, pp. 127-131.
14. Matjaž Žitnik, Matjaž Kavčič, Klemen Bučar, Andrej Mihelič, Rok Bohinc, "New results in high-resolution X-ray fluorescence spectroscopy", In: *Conference program, XXVIII ICPEAC, 28th International Conference on Photonic, Electronic and Atomic Collisions, 24-30 July, 2013, Lanzhou, China*, Guoqing Xiao, ed., [S. l., s. n.], 2013, 6 pp.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Jasmina Kožar Logar, "Used", In: *Poročanje in ovrednotenje zračnih in tekočinskih imisij ter meritev zunanjega sevanja v okolici NEK*, Matjaž Korun, et al, 1. izd., Ljubljana, Institut Jožef Stefan, 2013, pp. 37-54.
2. Žiga Šmit, "Ion-beam analysis methods", In: *Modern methods for analysing archaeological and historical glass*, Koen H. A. Janssens, ed., Chichester, Wiley-Blackwell, 2013, pp. 155-183.
3. Branko Vodenik, Boštjan Črnič, "Izpostavljenost zunanjemu sevanju", In: *Poročanje in ovrednotenje zračnih in tekočinskih imisij ter meritev zunanjega sevanja v okolici NEK*, Matjaž Korun, et al, 1. izd., Ljubljana, Institut Jožef Stefan, 2013, pp. 71-86.
4. Katarina Vogel-Mikuš, Iztok Arčon, Peter Kump, Primož Pelicon, Marijan Nečemer, Primož Vavpetič, Špela Koren, Marjana Regvar, "Analytical tools for exploring metal accumulation and tolerance in plants", In: *Phytotechnologies: remediation of environmental contaminants*, Naser A. Anjum, ed., Boca Raton (FL), Taylor & Francis, cop. 2013, pp. 443-495.
5. Benjamin Zorko, "Pitna voda in podtalnica", In: *Poročanje in ovrednotenje zračnih in tekočinskih imisij ter meritev zunanjega sevanja*

v okolici NEK, Matjaž Korun, et al, 1. izd., Ljubljana, Institut Jožef Stefan, 2013, pp. 23-36.

PATENT APPLICATION

1. Matjaž Vencelj, Matej Lipoglavšek, Rok Uršič, *A device to determine the photon interaction depth in a scintillating material*, P-201300428, Urad RS za intelektualno lastnino, 16.12.2013.

PATENT

1. Silvan Bucik, Borut Baričević, Borut Repič, Matjaž Vencelj, *A method of analog and digital signal processing of information contained in pulses, and a device for achieving the same*, SI23959 (A), Urad RS za intelektualno lastnino, 28.6.2013.

MENTORING

1. Jelena Gajević, *Electron screening in nuclear reactions*: doctoral dissertation, Ljubljana, 2013 (mentor Andrej Likar).
2. Boštjan Drolc, *Initiating independent monitoring of quality of gamma-cameras in Slovenia*: master's thesis, Ljubljana, 2013 (mentor Andrej Likar; co-mentor Gregor Omahen).
3. Alberto Sánchez Ortiz, *Algorithms for digital pulse processing*: master's thesis, Ljubljana, 2013 (mentor Matej Lipoglavšek; co-mentor Matjaž Vencelj).
4. Urška Gradišar, *Thermoluminescence analysis of irradiated food*: master's thesis, Ljubljana, 2013 (mentor Žiga Šmit; co-mentors Benjamin Zorko, Katarina Vogel-Mikuš and Marijan Nečemer).
5. Tina Vodopivec, *Liquid Scintillation Spectrometry and Tritium in Urine*: master's thesis, Ljubljana, 2013 (mentor Matej Lipoglavšek; co-mentor Jasmina Kožar Logar).

DEPARTMENT OF THIN FILMS AND SURFACES

F-3

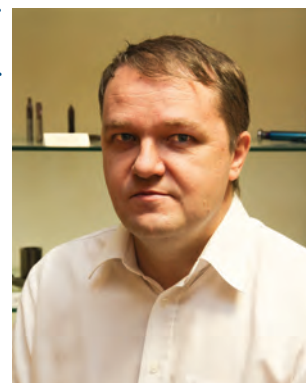
The main research field of the department is the development, deposition and characterization of hard protective PVD coatings, while research is also conducted in other fields of thin films and surface physics. The basic research is concentrated on the study of the physical and chemical properties of various multicomponent, multilayer and nanostructured coatings. Among the applied research, different coatings are developed for the protection of tools for various production processes in industry.

In the past few years the trendline of hard coating research has been concentrated into nanostructured coatings, i.e. nanolayer and nanocomposite coatings. The (Ti,Al,Si)N-based coatings are distinguished by the possibility to form 10-nm-sized TiN or TiAlN grains in a matrix of amorphous Si_3N_4 , provided the proper deposition conditions are met. A year ago we implemented this coating in industrial production; today it is in regular use by about 20 companies in Slovenia. Nevertheless, we are still engaged in its characterization and interpretation. Using transmission electron microscopy we analysed the coatings at the nanolevel (nanograin size and orientation), we explained the growth mechanisms and specific features of nanograin formation in nanolayer and nanocomposite coatings. This contribution was made by Aleksandar Miletić (University of Novi Sad, Serbia), which is the topic of his Ph.D thesis; he made most of the experimental work in our department.

We analysed the (Ti,Al,Si)N coating in semi-industrial experiments, where wear mechanisms in hard milling were studied in controlled conditions. The tools were either coated by a nanocomposite, or by one of the standard coatings for reference. A part of these tests was performed in the scope of the Nano-tool project (ERA-SME, partners Vienna Technical University and company EMO Orodjarna, d. o. o.). A series of experiments with a systematic evaluation and special emphasis on wear was performed by Dr. Halil Çalişkan from the University of Bartın, Turkey. He worked on this topic in the scope of his one-year stay in our department as part of his Ph.D thesis.

The appearance of micrometre-size growth defects is one of the major problems in the application of hard coatings. In this year we paid specific attention to those defects that originate in errors in the base material. We found that a lot of defects form on non-metal inclusions, which are found in all steels; this mainly applies to oxides (e.g. SiO_2) and sulphides (MnS). Their sputtering rate during etching is very different; therefore, in the phase of ion etching topographic changes on the surface appear. In the scope of the ESTEEM-2 project we were awarded session time in a high-resolution transmission electron microscope at the University of Graz, Austria. The samples were prepared by focused ion beam. Using this instrumentation we were able to analyse the contact between a non-metal inclusion and the coating grown above the inclusion. We evaluated the size of the micropores, which are the origin of poor adhesion on defects. With a systematic evaluation of the surface topography after cleaning, after etching and after coating deposition, we performed a statistical estimation of the defect appearance in different phases of depositing a hard coating. This work is performed in collaboration with the Faculty of Mechanical Engineering of the University of Maribor; it is the topic of the Ph.D thesis of Peter Gselman, our young researcher. Because our research group is one of the world's leading in the topic of growth-defect diagnostics, our co-worker Dr. Peter Panjan had an invited lecture at the International Conference of Metallurgical Coatings and Thin Films in San Diego, USA.

Research is performed on several applied projects, which are cofinanced by various companies. We started the development of multicomponent coatings for the protection of tools for hot forging, produced by the company Unior, d. d. The basic idea is in the addition of vanadium, which acts as a lubricant in high-temperature conditions. We performed several experiments using the so-called triangular targets made of two elements, which enables the deposition of a vertical composition gradient. So far we analysed the systems $\text{Cr}_x\text{Al}_{1-x}\text{N}$ and $\text{Cr}_x\text{V}_{1-x}\text{N}$. Going the classic way (using monolithic targets), 20 individual depositions would be needed, while by applying the triangular targets only one deposition was necessary. The use of this method is the Ph.D topic of our young researcher Aljaž Drnovšek. He thoroughly analysed the thus prepared samples from the tribological point of view and systematically analysed the influence of differ-



Head (since 1. 3. 2013):
Asst. Prof. Miha Čekada

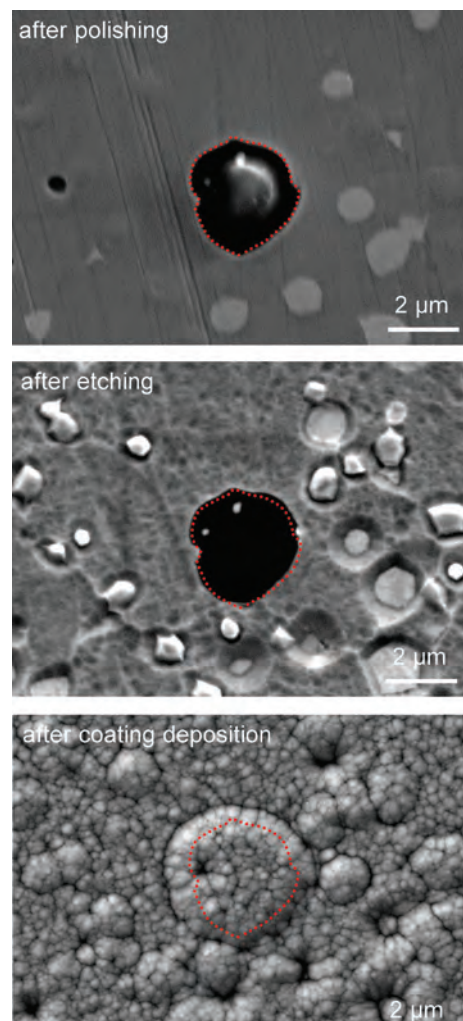


Figure 1: SiO_2 inclusion in stainless steel at various steps of coating preparation

We investigated the influence of various non-metallic inclusions in steel substrates on the mechanism of growth defect evolution.

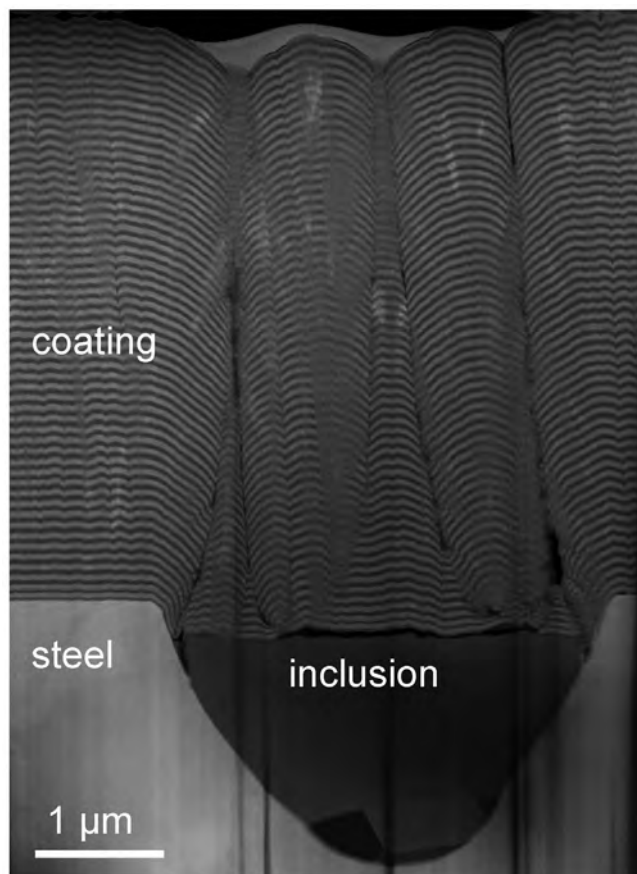


Figure 2: Cross-section through a TiAlN/CrN multilayer structure at the position of MnS inclusion, obtained using transmission electron microscopy

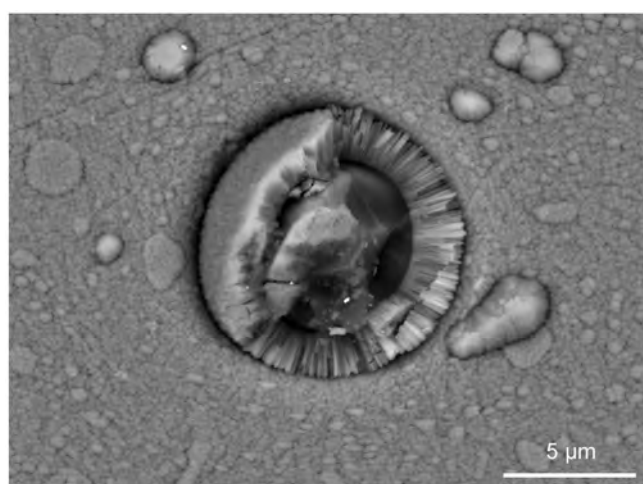


Figure 3: A partly delaminated defect on a TiAlN coating

We showed that during magnetron sputtering the ionisation zones play a major role in the transport of ions and electrons.

ent parameters on friction and wear. The ambient atmosphere choice (air, oxygen, nitrogen) was shown to have a major influence on the tribological properties of selected coatings.

In the previous years our tribological efforts were mainly limited to hard, self-lubricating coatings of diamond-like carbon. However, in collaboration with the company Nanotul, d. o. o., we initiated a project for testing the lubricating properties of standard coatings in combination with lubricants based on MoS₂ nanotubes. Other project-based collaborations are on-going with the companies Impol, d. d. (low-temperature coatings for aluminium alloys), Phos, d. o. o. (coatings on tools for pharmaceutical industry) and Kovinos, d. o. o. (coatings on cutting tools for hard machining).

There are several cases of collaboration, where the choice of a proper coating is only one aspect in a broad goal of the optimization of a certain technological process. One case deals with applying the TiAlN coating on high-speed steel after a cryogenic treatment (in collaboration with the University of Zagreb, Croatia), and another one with the protection of aluminium hot-extrusion tools by CrN coating (in collaboration with the Faculty of Natural Sciences and Technologies, University of Ljubljana).

The collaboration with the companies often continues after the expiry of a project. The work is usually done as an investigation, where we solve specific advanced technological problems. For the company Kolektor, d. d., we are developing a coating with a purpose to improve the tribological properties of saw blades that are used to cut commutator bodies. There is an intensive collaboration with the company Cetis, d. d., where our young researcher from the industry Vladan Mladenovič is employed. The topic of his research is surface structuring with various surface-treatment techniques (scratching, laser ablation, micromilling, electroerosion), and the analysis of these processes at microlevel. So far he has systematically analysed the topics of scratching and partly laser treatment, using the Taguchi method of experiment design.

In evaluating the degradation of functional materials, there are two well-established groups of tests. The first is the tribological testing where we evaluate the mechanical wear of two materials in sliding contact. The other is the corrosion testing where we are following the chemical destruction of the material in (mechanically speaking) static conditions. A synthesis of both concepts is the tribo-corrosion test, where we simultaneously measure the parameters of sliding wear (e.g., friction coefficient) and electrochemical parameters (corrosion potential, corrosion current). In this way we can in-situ evaluate the coating's degradation. The applicability of this principle was shown on two coatings (TiAgN and TiSiN).

In the scope of basic and industrial research we have been investigating for several years the influence of rotation on thin-film growth. Using a simulation that we developed for the industrial sputtering apparatus CC800/9 we studied the influence of rotation and target configuration on the structure of multilayer coatings and on the homogeneity of thin films. The simulation results showed that very periodic rotation modes, which depend on the turntable gear ratio, cause large variations both in thickness and in chemical composition of the coatings. Fewer periodic modes of rotation improve the film homogeneity, even though in certain rotating parameters large fluctuations may appear. Such simulations are a useful tool for the design of new PVD coatings. Our simulation attracted considerable attention from research and industry and led to the signing of a contract with one of the largest producers of PVD systems from Germany. This was also a topic of an invited lecture that our co-worker Dr. Matjaž Panjan had at the Society of Vacuum Coaters annual meeting in Providence, USA.

In collaboration with co-workers from Lawrence Berkeley National Laboratory (USA), Dr. Matjaž Panjan published a paper in Applied Physics

Letters, where they proposed a model for the transport of ions in high-power impulse magnetron sputtering. The model is based on the discovery of plasma structures called ionisation zones, which rotate in the magnetron plasma in the direction $E \times B$. In this model they proposed that inside the ionization zones the electron and ion densities are spatially separated; therefore, the electric field forms in an azimuthal direction. Thus, the electric field rotates in line with the zones. The ions primarily form within the ionization zones; therefore, they acquire the kinetic energy of the rotating electric field that accelerates them in the azimuthal direction up to an energy of 100 eV or more. This model is supported by experiments, conducted using mass and energy spectrometry in the scope of his post-doctoral stay in Berkley.

In this year Dr. Matjaž Panjan was a visiting researcher at the Montreal Polytechnic, Canada. He continued the work on nanocomposite hard coatings prepared by high-power impulse magnetron sputtering, already started in the scope of the post-doctoral stay in Montreal. The nanocomposite TiSiN coatings were tested for the protection of turbine blades against water erosion. These tests were conducted in collaboration with Rolls-Royce Canada. The coatings reduced the wear of blades by a factor of four. Within the COST action (topic: high power impulse magnetron sputtering) our young researcher Aljaž Drnovšek visited the same lab.

Within the Euratom project our task is the synthesis of hydrogenated carbon deposits, which should be as similar as possible to real impurity deposits in a fusion reactor. We keep informal collaboration with the Institute Vinča (Belgrade, Serbia) where we prepare various multilayer coatings (Ni/Ti, Al/Ti) to be laser-treated by our partners. Specially interesting results were obtained by the CrVN coating where we were able to synthesise a macroscopic wavy structure on the irradiation spots.

Some outstanding publications in the past year

1. Kek-Merl, D.; Panjan, P., Kovač, J.: Corrosion and surface study of sputtered AlW coatings with a range of tungsten contents, *Corrosion science*, 69 (2013), 359–368
2. Panjan, P., Gselman, P., Kek-Merl, D., Čekada, M., Dražič, G., Bončina, T., Zupanič, F.: Growth defect density in PVD hard coatings prepared by different deposition techniques, *Surface & coatings technology*, 237 (2013), 349–356
3. Panjan, M.: Influence of substrate rotation and target arrangement on the periodicity and uniformity of layered coatings, *Surface & coatings technology*, 235 (2013), 32–44

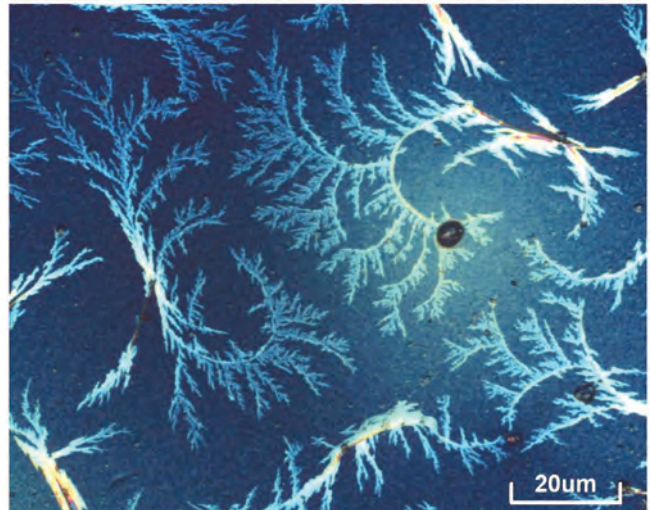


Figure 4: Surface of a CrVN coating after oxidation (750 °C, 2 min)

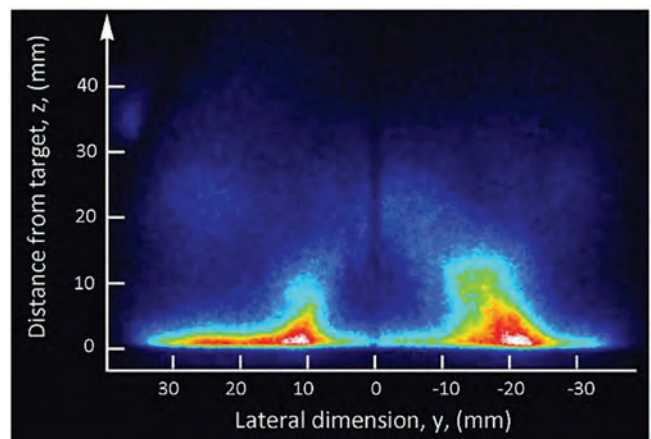


Figure 5: Image of ionization zones in high-power impulse magnetron sputtering, obtained with a high-speed camera

INTERNATIONAL PROJECTS

1. Simulation of Coating Deposition in Industrial PVD Systems
CemeCon AG
Dr. Matjaž Panjan
2. 7FP - EURATOM; Plasma Deposition of H:C-metal Coatings - 1.4.5-FU 3211-08-000102, FU07-CT-2007-00065
Ministry of Education, Science and Sport
Dr. Peter Panjan

RESEARCH PROGRAM

1. Thin Film Structures and Plasma Surface Engineering
Asst. Prof. Miha Čekada

R&D GRANTS AND CONTRACTS

1. Organic-Inorganic Thin Film Structures for Electronics Components
Dr. Peter Panjan
2. Research and Development of Rapid Production and Repair in Modern 3D Cutting Tools

- with Advanced Laser Technologies
Dr. Peter Panjan
3. Protected Permanent Magnets for Advanced High-Temperature Applications
Asst. Prof. Miha Čekada
4. Multifunctional Nanostructured Films for Artificial Implants - Corrosion and Tribocorrosion Processes
Dr. Darinka Kek Merl
5. Colour, Absorption and Protective Nanolayer Coatings for Aluminium Alloy
Dr. Peter Panjan
6. Functionalization of Biomedical Samples by Thermodynamic Non-equilibrium Gaseous Plasma
Dr. Peter Panjan
7. Toward Ecologically Benign Alternative for Cleaning of Delicate Biomedical Instruments
Dr. Peter Panjan
8. Self-lubricating and Wear Resistant PVD Hard Coatings Based on (V, Cr, Al, Ti)N for Hot-working Processes
Dr. Peter Panjan
9. Reduction of Friction and Tool Wear Using Advanced Lubricants and Protective PVD Coatings
Dr. Srečko Paskvale

NEW CONTRACTS

1. Study of functional properties of PVD-hard coatings in the system (Cr,Al)N
Kovinos d. o. o.
Dr. Peter Panjan
2. Self-lubricating and wear resistant PVD hard coatings based on (V,Cr,Al,Ti)N for hot-working processes
UNIOR Blacksmith Industry, d.d.
Dr. Peter Panjan

VISITORS FROM ABROAD

1. Dr. Christoph Schiffers, CemeCon AG, Würselen, Germany, 6. 11. 2013
2. Dr. Robert Franz, Dr. Marisa Figueiredo, Montanuniversität Leoben, Leoben, Austria, 21.-22. 11. 2013
3. Aleksandar Miletić, University of Novi Sad, Novi Sad, Serbia, 22. 7.-2. 8. 2013
4. Dr. Corneliu Porosnicu, National Institute for Laser, Plasma and Radiation Physics, Bucharest, Romania, 9.-10. 10. 2013

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3. Dr. Peter Panjan

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7. Peter Gselman, B. Sc.

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8. Joško Fišer
9. Damjan Matelič
10. Andrej Mohar
11. Tomaž Sirnik

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. André Anders, Matjaž Panjan, Robert Franz, Joakim Andersson, Pavel A. Ni, "Drifting potential humps in ionization zones: the propeller blades of high power impulse magnetron sputtering", *Appl. phys. lett.*, vol. 103, no. 14, pp. 144103-1-144103-4, 2013.
2. Matej Babič, Jože Balič, Matjaž Milfelner, Igor Belič, Peter Kokol, Milan Zorman, Peter Panjan, "Robot laser hardening and the problem of overlapping laser beam", *Adv. produc. engineer. manag.*, vol. 8, no. 1, pp. 25-32, 2013.
3. Matej Babič, Peter Panjan, Peter Kokol, Milan Zorman, Igor Belič, Timotej Verbovšek, "Using fractal dimensions for determination of porosity of robot laser-hardened specimens", *International journal of computer science issues*, vol. 1, issue 2, pp. 184-190, 2013.
4. Halil Çalişkan, Azmi Erdoğan, Peter Panjan, Mustafa Sabri Gök, Abdullah Cahit Karaođlanlı, "Micro-abrasion wear testing of multilayer nanocomposite TiAlSiN/TiSiN/TiAlN hard coatings deposited on AISI H11 steel", *Mater. tehnol.*, vol. 47, no. 5, pp. 563-568, 2013.
5. Halil Çalişkan, Cahit Kurbanoglu, Peter Panjan, Miha Čekada, Davorin Kramar, "Wear behavior and cutting performance of nanostructured hard coatings on cemented carbide cutting tools in hard milling", *Tribol. int.*, vol. 62, pp. 215-222, 2013.
6. Halil Çalişkan, Cahit Kurbanoglu, Peter Panjan, Davorin Kramar, "Investigation of the performance of carbide cutting tools with hard coatings in hard milling based on the response surface methodology", *Int. j. adv. manuf. technol.*, vol. 66, no. 5-8, pp. 883-893, 2013.
7. Peter Gselman, Peter Panjan, "Mikrostrukturne nepravilnosti trdih PVD-prevlek", *Vakuumist*, vol. 33, no. 4, pp. 11-22, 2013.
8. Darja Kek-Merl, Peter Panjan, Miha Čekada, Peter Gselman, Srečko Paskvale, "Tribocorrosion degradation of protective coatings on stainless steel", *Mater. tehnol.*, vol. 47, no. 4, pp. 435-439, 2013.
9. Darja Kek-Merl, Peter Panjan, Janez Kovač, "Corrosion and surface study of sputtered AlW coatings with a range of tungsten contents", *Corros. sci.*, vol. 69, pp. 359-368, 2013.
10. Darja Kek-Merl, Peter Panjan, Ingrid Milošev, "Effect of tungsten content on properties of PVD sputtered Al-W_x alloys", *Surf. eng.*, vol. 29, no. 4, pp. 281-286, 2013.
11. Matjaž Panjan, "Influence of substrate rotation and target arrangement on the periodicity and uniformity of layered coatings", *Surf. coat. technol.*, vol. 235, pp. 32-44, 2013.
12. Peter Panjan, Peter Gselman, Darja Kek-Merl, Miha Čekada, Matjaž Panjan, Goran Dražič, Tonica Bončina, Franc Zupanič, "Growth defect density in PVD hard coatings prepared by different deposition

techniques", In: Proceedings of the 40th International Conference on Metallurgical Coatings and Thin Films, 29 April 3 - May 2013, San Diego, California, *Surf. Coat. Technol.*, vol. 237, pp. 349-356, 2013.

13. Suzana Petrović, Davor Peruško, Branislav Salatić, Iva Bogdanović-Radović, Peter Panjan, Biljana Gaković, Dejan Pantelić, Milan Trtica, Branislav Jelenković, "Laser induced damage/ablation morphology on the 8(Al/Ti)/Si system in different ambient conditions", *Opt. Laser Technol.*, vol. 54, pp. 22-29, 2013.
14. Suzana Petrović, Branislav Salatić, Davor Peruško, Iva Bogdanović-Radović, Miha Čekada, Biljana Gaković, Dejan Pantelić, Milan Trtica, Branislav Jelenković, "Laser-induced structural and composition modification of multilayered Ni/Ti thin film in air and liquids", *Laser phys.*, vol. 23, no. 2, pp. 026004-1-026004-10, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Matej Babič, Peter Kokol, Matjaž Milfelner, Peter Panjan, Igor Belič, "Use algorithm for construction 3D visibility graphs to describe plastic and elastic deformation of robot laser hardened specimens", In: *Proceedings*, Miroslav Babić, ed., Slobodan Mitrović, ed., Kragujevac, Serbian Tribology Society, Faculty of Engineering, cop. 2013, pp. 348-350.
2. Matej Babič, Peter Kokol, Matjaž Milfelner, Peter Panjan, Igor Belič, "Use fractal geometry to describe friction of robot laser hardened specimen", In: *Proceedings*, Miroslav Babić, ed., Slobodan Mitrović, ed., Kragujevac, Serbian Tribology Society, Faculty of Engineering, cop. 2013, pp. 351-354.
3. Matej Babič, Peter Kokol, Matjaž Milfelner, Peter Panjan, Igor Belič, "Use new process in robot laser hardening to decrease wear of specimens", In: *Proceedings*, Miroslav Babić, ed., Slobodan Mitrović, ed., Kragujevac, Serbian Tribology Society, Faculty of Engineering, cop. 2013, pp. 355-358.
4. Matej Babič, Peter Kokol, Milan Zorman, Marko Marhl, Peter Panjan, Igor Belič, Matija Lokar, Andrej Mrvar, Matjaž Milfelner, "Analyse topographical properties of robot laser hardened specimens with topological properties of visibility graphs", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 96-97.
5. Aleksander Drenik, Alenka Vesel, Miran Mozetič, Peter Panjan, "Recombination of atomic oxygen and hydrogen on amorphous carbon", In: *Proceedings of the 15th International Conference on Fusion*

- Reactor Materials*, October 16-21, 2011, Charleston, SC, (Journal of nuclear materials, vol. 442, no. 1/3, suppl. 2013), Amsterdam, North-Holland, 2013, vol. 442, no. 1/3, suppl. 1, pp. S751-S754, 2013.
6. Peter Fajfar, Peter Panjan, Goran Kugler, Milan Terčelj, "Some reasons for decreased service time of dies for Al hot extrusion", In: *Surface effects and contact mechanics XI: computational methods and experiments*, (WIT transactions on engineering sciences, Vol. 78), J. Th. M. De Hosson, ed., Carlos Alberto Brebbia, ed., Southampton, WIT Press, cop. 2013, pp. 193-204.
 7. Vladan Mladenovič, Miha Čekada, Peter Panjan, "Characteristics of grooving by diamond needle-tip with various tip shapes and grooving parameters", In: *Conference & Expo 2013: technical proceedings of the 2013 NSTI Nanotechnology Conference & Expo - Nanotech 2013, May 12-16, 2013, Washington, DC*, [S. l.], TechConnect, zv. 2.
 8. Sanja Šolić, Peter Panjan, "Influence of deep cryogenic treatment of the HSS substrate on the PVD TiAlN coating properties", In: *Proceedings, 2nd Mediterranean Conference & New Challenges on Heat Treatment and Surface Engineering*, 11-14 June 2013, Dubrovnik - Cavtat, Croatia, Božidar Smoljan, ed., Božidar Matijević, ed., Zagreb, Croatian Society for Heat Treatment and Surface Engineering - CSHTSE, 2013, pp. 143-150.

DEPARTMENT OF SURFACE ENGINEERING AND OPTOELECTRONICS

F-4

The research program is associated with vacuum science, technology and applications. The main activities are focused on plasma science, the modification of advanced biomedical materials and products for improved biocompatibility, the characterization of inorganic, polymer and composite materials with different thin films on the surface, the modification and characterization of fusion-relevant materials, the thermodynamics of trapped gases and methods for sustaining a ultra-high-vacuum environment, vacuum opto-electronics, and basic research in the field of surface and thin-film characterization by electron spectroscopy techniques.



Head:
Prof. Miran Mozetič

Non-equilibrium gaseous plasma is a suitable medium for tailoring the surface properties of hydrocarbons. These materials, especially when fibrous, may interact strongly with reactive gaseous particles, causing localized heating and thus a loss of treatment uniformity. A method for diminishing such effects is the application of a uniform gaseous plasma with a very low power density. Such a plasma is created at low pressure, which allows for the minimization of three-body collisions. The collision frequency depends slightly on the type of gas and the kinetic temperature, but with a major dependence is on the gas pressure. The frequency often increases as the square of the gas pressure and in a rough approximation the value of 1 s^{-1} is achieved at a pressure of several 10 Pa. Plasma of low power density cannot be sustained in small chambers due to the rapid diffusion of reactive particles towards the walls where they tend to be lost by neutralization, recombination and relaxation.

The characteristics of gaseous plasma were studied in an industrial scale reactor of volume 3 m^3 . At a pressure of 13 Pa the plasma was sustained at a discharge power as low as 50 W. The discharge power density was therefore less than 20 W m^{-3} . Just for comparison, the minimal power density for sustaining plasma created by our surfatron discharge at the same vacuum level is over 10^7 W m^{-3} . Plasma in the large reactor was created by asymmetric capacitive coupled radio-frequency discharge. The powered electrode was immersed into the centre of the reactor, while the chamber walls made from stainless steel were grounded. Since the surface of the powered electrode was well over two orders of magnitude smaller than the surface of the grounded chamber, practically all the applied voltage appeared next to the powered electrode. The gas therefore remained at room temperature although the ionization and dissociation fractions of the gaseous molecules were reasonably high, of the order of 10^{-6} and 10^{-3} , respectively, corresponding to densities of 10^{16} and 10^{19} m^{-3} . Such a plasma is suitable for the treatment of fibrous polymer materials, such as textiles and allows for rapid functionalization with polar functional groups as well as the removal of surface impurities. A mild plasma created in oxygen or air, however, does not allow for a dramatic increase of surface morphology, so other reactive gaseous media should be used to obtain an extremely nanostructured surface of cellulose fibres.

The textile industry in developed countries is confronting the world's marketing conditions and competitive challenges that are driving it towards the development of advanced, highly functional textiles and textiles with higher added value. The conventional textile finishing techniques are wet chemical modifications where water and rather hazardous chemicals are used in large quantities and waste waters need to be processed before discharging the effluent, whereas the most problematic factors are ecological impacts to the environment and effects on human health. The increasing environmental concerns and demands for an environmentally friendly processing of textiles leads to the development of new technologies based on the modification of functional properties with nanoparticles. Such textiles exhibit improved radiation protection, bacteriostatic effects or improved flame-retardation. A major scientific concern about the application of nanoparticles is poor adsorption onto polymer fibres, which is due to a poor surface morphology. Although plasma created in air, oxygen, water vapour

Excellent functional properties for fibrous cellulose materials were achieved by the proper selection of plasma parameters.

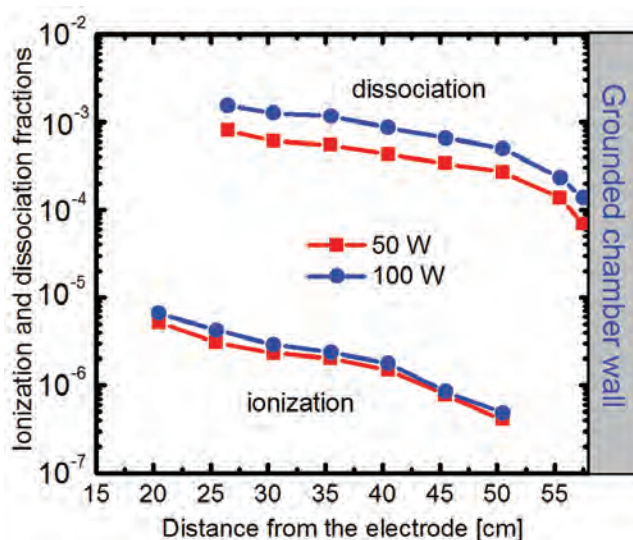


Figure 1: The ionization and dissociation fractions of oxygen molecules in plasma created in 3 m^3 large reactor versus distance from the wall.

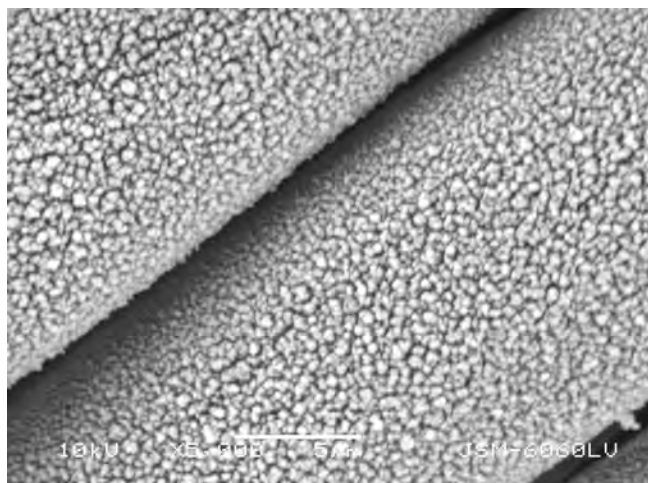


Figure 2: SEM image of cellulose fibres treated in moist CF_4 plasma.

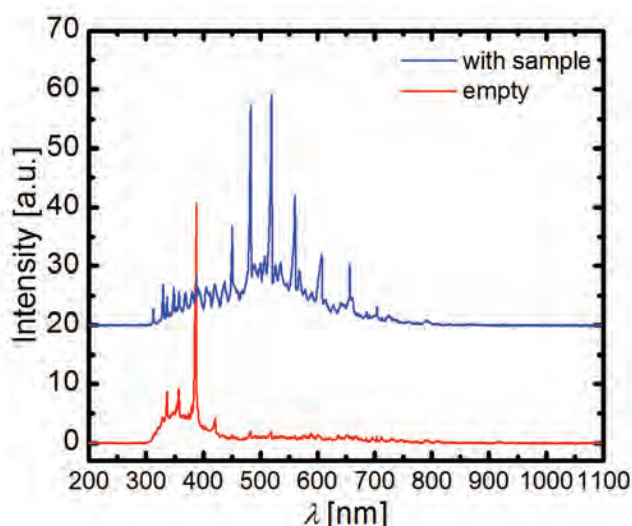


Figure 3: Optical spectra of plasma created in unloaded reactor in pure CF_4 (red curve) and reactor loaded with cellulose fabrics.

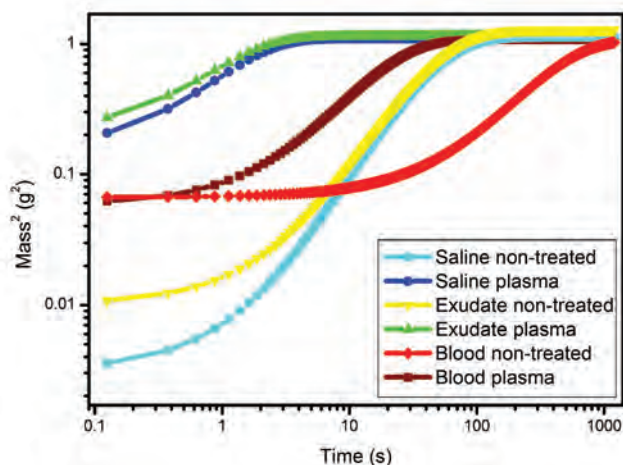


Figure 4: Average wetting rise curves for non-treated and plasma treated non-woven viscose for three different liquids.

or carbon dioxide allows for a stripped, cleaned and more distinct macro-fibril structure, it does not ensure the optimal adsorption of nanoparticles.

A method for the treatment of cellulose fibres that allows for almost optimal nano-structuring has been invented. The textiles were treated with a plasma created in tetrafluoromethane (CF_4) with an admixture of water vapour (H_2O) in order to obtain an extremely rich surface morphology. The right treatment parameters allowed for etching resulting in a nanostructured surface with grain dimensions of roughly between 150 and 500 nm. The surface texture was uniform on a large area allowing for excellent absorption properties. The CF_4 plasma is otherwise applied to obtain the opposite effect (hydrophobicity) but the right admixture of water vapour allowed for the creation of reactive particles that lead to extremely selective etching of cellulose fibres. Since the dissociation energy of a water molecule is several times lower than of CF_4 the O and OH radicals abound in plasma created in such a gas mixture and readily interact with fluorinated cellulose materials, causing etching of fluorine-rich segments. The etching was monitored using optical emission spectroscopy. The optical spectrum of plasma created in rather pure CF_4 is rich in CF_x bands as well as continua especially in the near-ultraviolet range of wavelengths. In the case the plasma reactor is loaded with wet cellulose fabrics the optical spectrum is completely different. Instead of the CF_x spectral features the spectrum reveals an extremely strong emission that originates from the transitions of CO radicals. These radicals are formed upon the etching of cellulose material with gaseous plasma created in CF_4 gas with admixture of water vapour.

Wounds are considered as the major cause of morbidity and impaired quality of life, especially by patients suffering from diabetes. It has been estimated that over 1% of the world's population suffer from serious complications causing chronic ulcer wounds. The average cost of a treatment cycle is estimated to about €6600 for leg ulcers and €10,000 for foot ulcers. Wound dressings are regarded as the medical means of cleaning and protecting wounds in order to facilitate and accelerate the healing process. Although the healing process of wounds is a natural process, the speed of healing and fluid loss is still one of the major challenges. Significant improvements in developing wound-dressing products have been recorded since earliest times, but the properties of those materials currently used are still far from challenging the characteristics that chronic wounds exhibit. In order to improve the sorption kinetics of non-woven viscose materials, nowadays widely used as absorption material, we optimized the plasma parameters for the deep functionalization of such fibrous materials. Since charged particles are lost by neutralization on the fibres' surface we rather treated these materials with an extremely non-equilibrium plasma created in moist oxygen. The density of the charged particles was of the order of $10^{15} m^{-3}$, while the neutral atom density was as high as $2 \times 10^{21} m^{-3}$. The neutral atoms do not interact aggressively with viscose materials, so they can diffuse deep into non-woven materials where they cause rather uniform functionalization with polar functional groups as well as the removal of any hydrophobic impurities that might be present on the fibre surfaces. The result of such a deep functionalization is a dramatic improvement of the sorption kinetics. Water and saline solution is soaked by plasma-treated materials about $100 \times$ faster than by untreated materials, and the improvement for exudate and blood is up to an order of magnitude.

Plasma nano-science remains a priority of our research due to promising results and the broad range of future application from photovoltaics to biomedicine. We reported on the chemical synthesis of the arrays of silicon oxide nano-dots and their self-organization on the surface via physical processes triggered by surface charges. The method based on chemically active oxygen plasma leads to the rearrangement of nanostructures and eventually to the formation of groups of nano-dots. This behaviour is explained in terms of

the effect of electric field on the kinetics of surface processes. The direct measurements of the electric charges on the surface demonstrate that the charge correlates with the density and arrangement of nano-dots within the array. Extensive numerical simulations support the proposed mechanism and prove the critical role of the electric charges in the self-organization. This simple and environment-friendly self-guided process could be used in the chemical synthesis of large arrays of nano-dots on semiconducting surfaces for a variety of applications in catalysis, energy conversion and storage, photochemistry, environmental, bio-sensing, and several others.

The characterization of surfaces and interfaces, layered structures and nanomaterials requires the application of advanced surface-sensitive analytical techniques. In our department X-ray photoelectron spectroscopy (XPS), secondary-ion mass spectroscopy (ToF-SIMS), Auger electron spectroscopy (AES) and atomic force microscopy (AFM) have been used successfully, both for basic research and the characterization of technological samples. Our research group is recognized worldwide as a leading group in the research field of the depth profiling of thin films and multilayers with a high depth resolution. In this field we continued studying the influences of different distortion effects on depth resolution upon measurements of the elements distribution in thin films and multi-layered structures. We succeeded to improve the existing mixing-roughness-information (MRI) model describing the influence of atomic mixing by ion bombardment, information depth of the analysed species, and the surface and interface roughness of the specimen. We introduced a new description for interface roughness with an asymmetrical function that differs from the Gaussian function used conventionally in analytical work. A comparison between the model and the experimental determination of the depth profiles shows that a realistic non-Gaussian function has to be taken into account if high accuracy in quantification of sputter depth profiles is required. This is of particular importance for analyses of ultra-thin multilayer structures (up to 10 nm), which are frequently involved in advanced applications.

Aminopropylsilanes bonded on silicon substrates promote adhesion between the inorganic material and organic compounds. Aminosilanes are self-assembled molecules since they form a multi-layer structure on a surface over a certain time span after deposition. Such a modified surface can be used in many applications from biological studies to attaching metal nanoparticles, and sensor applications. We performed a systematic characterization of a silicon surface modified by different self-assembled aminopropylsilanes (APS) with the purpose of using them in sensor applications. Single-crystal silicon wafers were modified with aminosilanes having different numbers of bonding sites: 3-aminopropyl-trimethoxysilane (APTMS), 3-aminopropyl-diethoxymethylsilane (APRDMS) and 3-aminopropyl-ethoxydimethylsilane (APREMS). We deposited the self-assembled layers from a solution of aminosilanes in toluene under various reaction conditions. The surface composition, the chemical bonding and the surface morphology were determined using XPS, ToF-SIMS, AFM and SEM. Our results show that the reactivity with the Si-oxide layer and the polymerization of aminosilanes depend on the number of possible bonding sites. The APTMS reacted most intensively with the Si-oxide layer; a less intensive reaction was observed for the APRDMS; and the least intensive reaction was observed for the APREMS. For aminosilane molecules with more bonding sites the effect of the polymerization is more intensive, resulting in island formation and a rougher surface. At 25 °C the polymerization is more intensive than at elevated temperatures, which we attribute to a faster deposition of the molecules at higher temperatures.

In collaboration with the company Melamin from Kočevje, Slovenia, we have studied novel materials for thermal insulation panels. Extensive work

The recently granted EU project “IP4Plasma” also involves a Slovenian industrial partner Tosama and the major goal is the development of functional textiles.

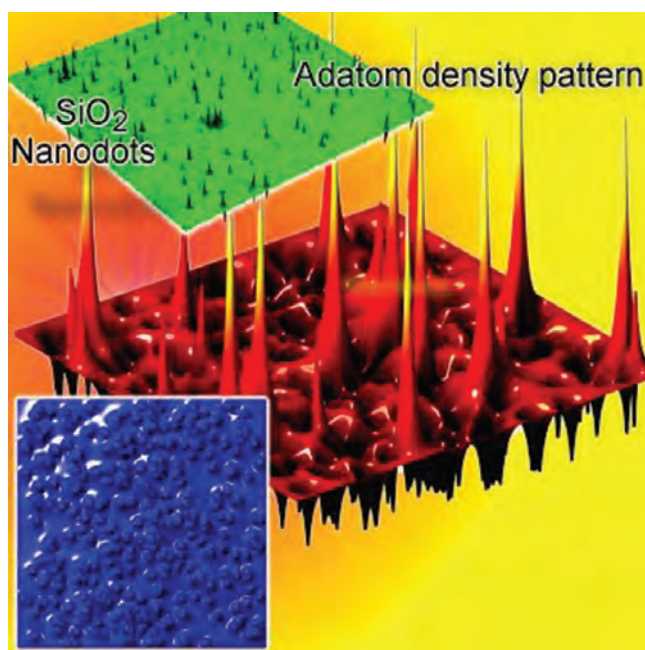


Figure 5: Simulated ad-atom density patterns defining QD movements upon the exposure of Si wafers to oxygen plasma and corresponding AFM images.

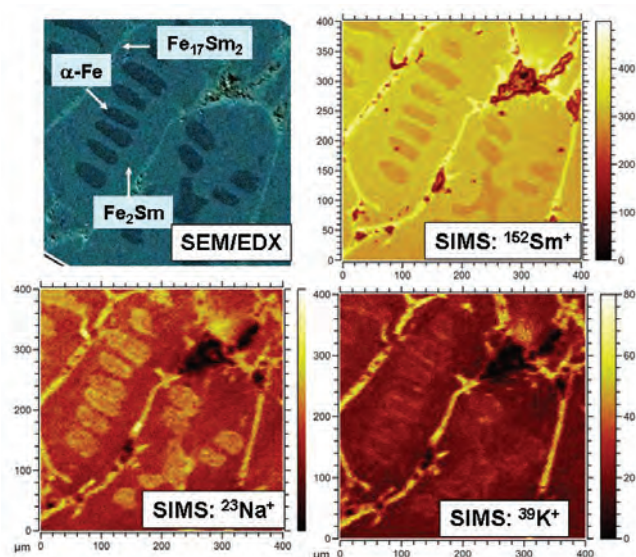


Figure 6: ToF-SIMS characterization of Fe-Sm alloy after annealing at 1250 °C allows for the identification of phases as well as the distribution of minor elements, thanks to a high sensitivity and lateral resolution.

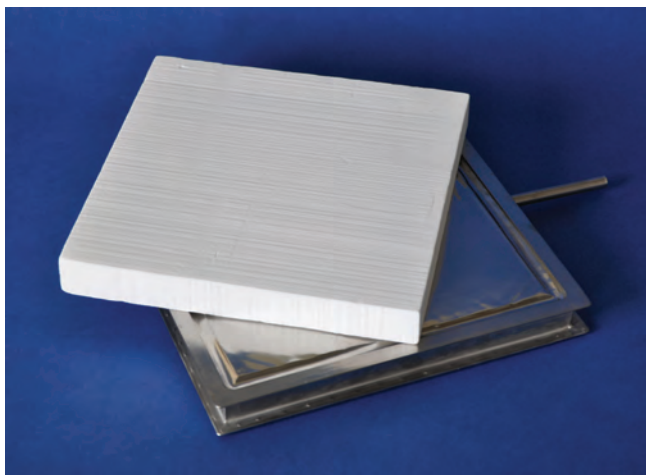


Figure 7: A melamine-formaldehyde foam sample that is to be encapsulated in vacuum insulation panels.

performed on rigid melamine-formaldehyde (MF) foams clearly showed it is a suitable material, which may substitute currently used organic foams.

All foams used in a standard way in industrial practise contain additives like bromine, which are added due to the required self-extinguishing properties of insulating materials. Such additives have to be abandoned by 2015. Besides the fact that the MF foams are already self-extinguishable since they contain appreciable amounts of nitrogen, they are also distinguished by a higher application temperature (180°C) comparing to the currently applied foams made on the basis of polystyrene or polypropylene. We tested the MF samples as potential candidates for core materials used in vacuum insulation panels. We developed a unique procedure for the evaluation of the thermal conductivity as a function of pressure in the foam, which also allows for long-term monitoring of the outgassing rate. The evacuated MF foams have a low thermal conductivity of about 6 W/K, which is equivalent to organic foams, but due to the extremely low outgassing rates they are even more suitable for vacuum panels.

Our fusion-related EURATOM project is focused on hydrogen-metal interaction, in particular with fusion relevant metals such as beryllium and tungsten. These two metals will represent the “first wall” (plasma-facing components) of international fusion reactor ITER. Thermal load and ion impact will induce tritium retention in mixed deposits of tungsten and beryllium. Since only little general data about such films exist, the knowledge should be improved so possible mechanisms involved at interaction between these materials and hydrogen were investigated. We studied properties of films containing various amounts of Be and W. Research on the outgassing rate was performed and subsequent hydrogen/deuterium gas permeation technique at temperatures up to 400 °C was elaborated. The same method has been applied for characterization of duplex membranes (a low-permeable film on a high-permeable substrate) and has been proved as a reliable technique, so a few papers have been published in last years on pure Be and W films. The most outstanding finding was an extremely high capability of nano-structured W film to retain hydrogen, reaching values as high as about 0.1H/W, which had not been expected since bulk tungsten is renowned for its very low hydrogen solubility. Films with various Be/W ratios were deposited at C. Lungu’s laboratory at NILPRP, Bucharest, Romania, by the TVA method and thoroughly characterized by SEM and XPS in order to confirm the range of set values for Be/W ratio. A series of precise hydrogen-permeability measurements combined with long-term outgassing-rate measurements were realized. In addition, various experimental techniques were applied for the evaluation of film properties, like SEM, XRD, XPS and AFM.

Some outstanding publications in the past year

1. Lazović, S., Puač, N., Spasić, K., Malović, G., Cvelbar, U., Mozetič, M., Petrović, Z.: Plasma properties in a large-volume, cylindrical and asymmetric radio-frequency capacitively coupled industrial-prototype reactor. *Journal of Physics D, Applied physics*, 2013, vol. 46, no. 7, 075201-1–075201-8
2. Peršin, Z., Devetak, M., Drevenšek Olenik, I., Vesel, A., Mozetič, M., Stana-Kleinschek, K.: The study of plasma’s modification effects in viscose used as an absorbent for wound-relevant fluids. *Carbohydrate polymers*, 2013, vol. 97, issue. 1, 143–151
3. Levichenko, I., Cvelbar, U., Modic, M., Filipič, G., Zhong, X., Mozetič, M., Ostrikov, K.: Nanoherding: plasma-chemical synthesis and electric-charge-driven self-organization of SiO₂ nanodots. *The journal of physical chemistry letters*, 2013, vol. 4, issue 4, 681–686
4. Liu, Y., Jian, W., Wang, J. Y., Hofmann, S., Kovač, J.: Influence of non-Gaussian roughness on sputter depth profiles. *Applied Surface Science*, 2013, vol. 276, 447–453
5. Zajec, B., Nemanič, V., Žumer, M., Porosnicu Corneliu Lungu, C.: Hydrogen permeability through beryllium films and the impact of surface oxides. *Journal of Nuclear Materials*, 2013, vol. 443, 185–194

Awards and appointments

1. Asst. Prof. Alenka Vesel; Award for the most cited article in the *Journal Dyes and Pigments* in years 2010 and 2011; title of the article: “*Colorimetric properties of reversible thermochromic printing inks*”

Organization of conferences, congresses and meetings

1. 20th International scientific meeting of Vacuum Science and Technology, Jeruzalem, Ljutomersko-Ormoške gorice, 9.–10. 5. 2013

INTERNATIONAL PROJECTS

1. Development of a Vacuum Measurement Method with Respect to Vacuum Glazing
AGC Glass Europe
Dr. Vincenc Nemanič
2. 7FP - EURATOM; Removal of Deposits by Neutral Oxygen and Nitrogen Atoms - 1.4.2.-FU; 3211-08-000102, FU07-CT-2007-00065
Ministry of Higher Education, Science and Technology
Prof. Miran Mozetič
3. 7FP - EURATOM-MHEST, 1.4.4-FU; Deuterium Interaction Kinetics with BE, W and Mixtures Relevant to ITER and DEMO
Ministry of Education, Science and Sport
Dr. Vincenc Nemanič
4. EFDA-JET 2013 Experimental Campaigns
Ministry of Education, Science and Sport
Dr. Aleksander Drenik
5. 7FP - EURATOM-MHEST, WP13-IPH-A01-P3-02/MESCS/PS, Permeation Measurements of Mixed Be/W Layers
Ministry of Education, Science and Sport
Dr. Vincenc Nemanič
6. EFDA-JET 2013 Analysis of Mixed Materials on ITER-like Wall Samples Using XPS/AES
Ministry of Education, Science and Sport
Dr. Vincenc Nemanič
7. COST MP1101; Biomedical Applications of Atmospheric Pressure Plasma Technology
COST Office
Prof. Uroš Cvelbar
8. NATO Planning Grant; SfP 984555; Atmospheric Pressure Plasma Jet for Neutralisation of CBW (Chemical Biological Weapons)
NATO - North Atlantic Treaty Organisation
Prof. Uroš Cvelbar
9. COST TD1208; Electrical Discharges with Liquids for Future Applications; COST Training School on Liquid Discharges
COST Office
Prof. Uroš Cvelbar
10. Plasma Synthesis and Application of Nanowalls
Slovenian Research Agency
Prof. Uroš Cvelbar
11. Plasma Synthesis and Deposition of Quantum Dots
Slovenian Research Agency
Prof. Uroš Cvelbar
12. Determination of Interdiffusion Coefficients in Nano-layered Structures by High Resolution Depth Profiling
Slovenian Research Agency
Asst. Prof. Janez Kovač
13. Plasma Treatment of Titanium Stents
Slovenian Research Agency
Prof. Uroš Cvelbar
14. Plasma-assisted Synthesis of Nano-objects
Slovenian Research Agency
Prof. Uroš Cvelbar
15. Formation of Nanocomposite Thin Films in Dusty Magnetized Plasma
Slovenian Research Agency
Asst. Prof. Alenka Vesel
16. Hydrogen Interaction With W/Be Films Relevant for Fusion Reactors
Slovenian Research Agency
Dr. Vincenc Nemanič
17. Characterization of Non-equilibrium Plasma for Modification of Nano and Biocompatible Materials
Slovenian Research Agency
Prof. Miran Mozetič
18. Ultra Nanoporous Nanowires of Metal Oxides
Slovenian Research Agency
Prof. Uroš Cvelbar
19. Development and Investigation of Optimal Regimes of RF Conditioning of Uragan-2M Vacuum Chamber Walls using Optical and Probe Methods of Plasma Diagnostics
Slovenian Research Agency
Prof. Miran Mozetič
20. Characterization of Processing Plasma with Catalytic and Cutoff Probes
Slovenian Research Agency
Prof. Miran Mozetič

RESEARCH PROGRAMS

1. Vacuum Technique and Materials for Electronics
Dr. Vincenc Nemanič
2. Thin Film Structures and Plasma Surface Engineering
Prof. Miran Mozetič

R&D GRANTS AND CONTRACTS

1. Near-Net Shape Nanoparticle-Reinforced Polymer-Composites for Highly-Loaded Advanced Mechanical Components with Superior Tribological Performance
Asst. Prof. Janez Kovač
2. Organic-Inorganic Thin Film Structures for Electronics Components
Asst. Prof. Janez Kovač
3. Research and Development of Integrated Overvoltage Protection Devices Based on Gaseous Discharger Toward a Reliable Miniature Technical Solution
Dr. Vincenc Nemanič
4. Development of Advanced Processes for Attending High Efficient Nano Modified Textile Materials
Prof. Miran Mozetič
5. Development of the Functional Textiles Used for the Treatment of Diabetic Foot (Malum perforans)
Prof. Miran Mozetič
6. New Materials for Printed Sensors and Indicators and their Integration in Smart Printed Matter
Asst. Prof. Alenka Vesel
7. Multifunctional Nanostructured Films for Artificial Implants - Corrosion and Tribo-corrosion Processes
Asst. Prof. Janez Kovač
8. Synthesis of Nanowires for Regenerative Energy Cells
Prof. Uroš Cvelbar
9. Colour, Absorption and Protective Nanolayer Coatings for Aluminium Alloy
Asst. Prof. Janez Kovač
10. Functionalization of Biomedical Samples by Thermodynamic Non-equilibrium Gaseous Plasma
Prof. Miran Mozetič
11. Toward Ecologically Benign Alternative for Cleaning of Delicate Biomedical Instruments
Asst. Prof. Alenka Vesel
12. Self-lubricating and Wear Resistant PVD Hard Coatings Based on (V,Cr,Al,Ti)N for Hot-working Processes
Dr. Peter Panjan
13. Preparation of Hemocompatible Polymeric Surfaces for Biomedical Applications
Dr. Ita Junkar

NEW CONTRACTS

1. Investigation of Melamine Foams as the Core Material in Vacuum Thermal Insulation
Melamin Chemical Factory, d. d.
Dr. Vincenc Nemanič
2. Investigation of Evaluation Methods for Vacuum Insulation Panel Performance Testing in Accordance with Draft of ISO Standard
Stirolab, d. o. o.
Dr. Vincenc Nemanič
3. Environmentally Friendly Cleaning of Components for Large Vacuum Systems
Vacutech Vacuum Technologies and Systems, d. o. o.
Prof. Miran Mozetič
4. Characteristics of Gaseous Plasma in Gaps
Kolektor Sikom d. o. o.
Prof. Uroš Cvelbar
5. Advanced Functional Implant
Ekliptik, d. o. o.
Dr. Ita Junkar
6. Nanowire Synthesis for Regenerative Energy Cells
Kolektor Group, d. o. o.
Prof. Uroš Cvelbar
7. Functionalization of biomedical samples with thermodynamically non-equilibrium gaseous plasma
Bia Separations
Prof. Miran Mozetič
8. Toward Ecologically Benign Alternative for Cleaning of Delicate Biomedical Instruments
Ekliptik, d.o.o.
Asst. Prof. Alenka Vesel

VISITORS FROM ABROAD

1. Branislav Brindić, Marko Gocić, Ivan Tasić, Rade Nikolov, Harder Digital Sova, Niš, Republic of Serbia, 14.-15. 2. 2013
2. Dr. Davide Mariotti, Ulster University, Great Britain, 19.-24. 2. 2013
3. Dr. Nikša Krstulović, Institute for Physics, Zagreb, Croatia, 26. 4. 2013
4. Agelos Mourkas, Univerza v Ioannini, Ioannina, Greece, 12. 4. -12. 7. 2013
5. Yi Liu, Shantou University, Shantou, China, 21. 5.-3. 6. 2013
6. Prof. Jiang Wang, Shantou University, Shantou, China, 21. 5.-3. 6. 2013
7. Dr. Vladimír Sedlárik, Dr. Marian Lehockey, Dr. František Bílek, Tomas Bata University, Zlin, Czech Republic, 1.-3. 7. 2013
8. Dr. Petr Slobodian, Tomas Bata University, Zlin, Czech Republic, 17. 6. -14. 7. 2013
9. Dr. Xiao Xia Zhong, Shanghai University, Shanghai, China, 15.-18. 7. 2013
10. Dr. Aleš Mraček, Tomas Bata University, Zlin, Czech Republic, 19.-22. 8. 2013
11. Robert Olejník, Tomas Bata University, Zlin, Czech Republic 27. 7.-5. 9. 2013
12. Dr. Cristian P. Lungu, Dr. Corneliu Porosnicu, National Institute for Laser, Plasma and Radiation Physics, Bucharest, Romania, 2.-6. 9. 2013
13. Dr. Ognjen Milat, Institute for Physics, Zagreb, Croatia, 19.-20. 9. 2013
14. Dr. Richard Clergereaux, Dr. Antoine Belinger, LAPLACE CNRS, Toulouse, France, 11.-14. 11. 2013
15. Dr. Nikša Krstulović, Institute for Physics, Zagreb, Croatia, 29. 11. 2013
16. Dr. Igor Levchenko, CSIRO Institute, Sydney, Australia, 10. 11.-2. 12. 2013
17. Dr. Nikša Krstulović, Institute for Physics, Zagreb, Croatia, 5. 12. 2013
18. Dr. Danijela Vujošević, Institute for public health of Montenegro, Podgorica, Montenegro, 15.-24. 12. 2013
19. Dr. Nikša Krstulović, Institute for Physics, Zagreb, Croatia, 23. 12. 2013
20. P. Eiselt, P. Zieger, F. Heinz, Plasmalt GmbH, Lebring, Austria, 23. 12. 2013
21. Dr. Nikša Krstulović, Institute for Physics, Zagreb, Croatia, 30. 12. 2013

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9. Dr. Martina Modic
10. Dr. Rok Zaplotnik

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11. Gregor Filipič, B. Sc.
12. Gregor Jakša, B. Sc.
13. *Borut Praček, B. Sc., retired 01.09.13*
14. Gregor Primc, B. Sc.
15. Nina Recek, B. Sc.
16. Marko Žumer, B. Sc.

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17. *Gregor Avbelj, B. Sc., left 01.10.13*
18. Tatjana Filipič, B. Sc.

Technical and administrative staff

19. Urška Kisovec, B. Sc.
20. Janez Trtnik

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. František Bílek, Kateřina Sulovská, Marián Lehocký, Petr Sába, Petr Humpolíček, Miran Mozetič, Ita Junkar, "Preparation of active antibacterial LDPE surface through multistep physicochemical approach II: graft type effect on antibacterial properties", *Colloids surf., B Biointerfaces*, vol. 102, pp. 842-848, 2013.
2. Milan Bizjak, Blaž Karpe, Gregor Jakša, Janez Kovač, "Surface precipitation of chromium in rapidly solidified CuCr alloys", *Appl. surf. sci.*, vol. 277, pp. 83-87, 2013.
3. Uroš Cvelbar, "Interaction of non-equilibrium oxygen plasma with sintered graphite", In: Proceedings of the SURFINF - SREM III, 3rd International Conference on Progress Surface, Interface and Thin Films 2012, May 14-18, 2012, Bratislava, Slovakia, *Appl. Surf. Sci.*, vol. 269, pp. 33-36, 2013.
4. Aleksander Drenik, L. Salamon, Rok Zaplotnik, Alenka Vesel, Miran Mozetič, "Erosion of amorphous carbon layers in the afterglow of oxygen microwave plasma", In: Proceeding of the JVC-14, 14th Joint Vacuum Conference, EVC-12, 12th European Vacuum Conference, AMDVG-11, 11th Annual Meeting of the German Vacuum Society, CroSloVM-19, 19th Croatian-Slovenian Vacuum Meeting, [4-8 June 2012, Dubrovnik, Croatia], *Vacuum*, vol. 98, pp. 45-48, 2013.
5. Aleksander Drenik, Pavel Yuryev, Alenka Vesel, J. Margot, Richard Clergereaux, "Observation of plasma instabilities related to dust particle growth mechanisms in electron cyclotron resonance plasmas", *Phys. plasmas*, vol. 20, no. 10, pp. 100701-1-100701-4, 2013.
6. Lidija Fras Zemljič, Tina Tkavc, Alenka Vesel, Olivera Šauperl, "Chitosan coatings onto polyethylene terephthalate for the development of potential active packaging material", *Appl. surf. sci.*, vol. 265, pp. 697-703, 2013.
7. Jorge López García, Petr Humpolíček, Marián Lehocký, Ita Junkar, Miran Mozetič, "Different source atelocollagen thin films: preparation, process optimisation and its influence on the interaction with eukaryotic cells: priprava, optimizacija procesa in vpliv na interakcije z evkariontičnimi celicami", *Mater. tehnol.*, vol. 47, no. 4, pp. 467-471, 2013.
8. Gorazd Golob, Marta Klanjšek Gunde, Marie Kaplanová, Mladen Lovreček, Miran Mozetič, "Surface free energy modification of crude rubber using oxygen plasma and UV laser-treatment", *Polym. polym. compos.*, vol. 21, no. 1, pp. 51-53, 2013.
9. Gregor Jakša, Bogdan Štefane, Janez Kovač, "XPS and AFM characterization of aminosilanes with different numbers of bondingsites on a silicon wafer", *Surf. interface anal.*, vol. 45, no. 11/12, pp. 1709-1713, 2013.
10. Ita Junkar, "Plasma treatment of amorphous and semicrystalline polymers for improved biocompatibility", In: Proceeding of the JVC-14, 14th Joint Vacuum Conference, EVC-12, 12th European Vacuum Conference, AMDVG-11, 11th Annual Meeting of the German Vacuum Society, CroSloVM-19, 19th Croatian-Slovenian Vacuum Meeting, [4-8 June 2012, Dubrovnik, Croatia], *Vacuum*, vol. 98, pp. 111-115, 2013.
11. Darja Kek-Merl, Peter Panjan, Janez Kovač, "Corrosion and surface study of sputtered AIW coatings with a range of tungsten contents", *Corros. sci.*, vol. 69, pp. 359-368, 2013.
12. U. Lačnjevac, B. M. Jović, Lj. Gajić-Krstajić, Janez Kovač, V. D. Jović, N. V. Krstajić, "Ti substrate coated with composite CrMoO₂ coatings as highly selective cathode materials in hypochlorite production", *Electrochim. acta*, vol. 96, pp. 34-42, 2013.
13. Saša Lazović, Nevena Puač, Kosta Spasić, Gordana Malović, Uroš Cvelbar, Miran Mozetič, Zoran Lj. Petrović, "Plasma properties in a large-volume, cylindrical and asymmetric radio-frequency capacitively coupled industrial-prototype reactor", *J. phys., D, Appl. phys.*, vol. 46, no. 7, pp. 075201-1-075201-8, 2013.
14. Igor Levchenko, Uroš Cvelbar, Martina Modic, Gregor Filipič, Xiaoxia Zhong, Miran Mozetič, Kostya Ostrikov, "Nanoherding: plasma-chemical synthesis and electric-charge-driven self organization of SiO₂ nanodots", *J. phys. chem. lett.*, vol. 4, issue 4, pp. 681-686, 2013.
15. Y. Liu, J. Y. Wang, Siegfried Hofmann, Janez Kovač, "Influence of non-Gaussian roughness on sputter depth profiles", *Appl. surf. sci.*, vol. 276, pp. 447-453, 2013.
16. Y. Lu, S. F. Xu, X. X. Zhong, Kostya Ostrikov, Uroš Cvelbar, D. Mariotti, "Characterization of a DC-driven microplasma between a capillary tube

- and water surface", *Europhys. Lett.*, vol. 102, no. 1, pp. 15002-1-15002-6, 2013.
17. Martha Merchan, Jana Sedlarikova, Alenka Vesel, Michal Machovsky, Vladimír Sedlarik, Petr Sába, "Antimicrobial silver nitrate-doped polyvinyl chloride cast films: influence of solvent on morphology and mechanical properties", *Int. j. polym. mater.*, vol. 62, no. 2, pp. 101-108, 2013.
 18. Momir Milosavljević, Marko Obradović, Ana Grce, Davor Peruško, Dejan Pjević, Janez Kovač, Goran Dražič, Chris Jeynes, "High dose ion irradiation effects on immiscible AlN/TiN nano-scaled multilayers", In: Proceedings of the 6th International Conference on Technological Advances of Thin Films & Surface Coatings, July 14-17, 2012, Singapore, *Thin Solid Films*, vol. 544, pp. 562-566, 2013.
 19. Momir Milosavljević, Dragan Toprek, Marko Obradović, Ana Grce, Davor Peruško, Goran Dražič, Janez Kovač, Kevin P. Homewood, "Ion irradiation induced solid-state amorphous reaction in Ni/Ti multilayers", *Appl. Surf. Sci.*, vol. 268, pp. 516-523, 2013.
 20. Miran Mozetič, Alenka Vesel, "Thermal defunctionalization of an oxygen-plasma-treated polyethersulfone", *Mater. Tehnol.*, vol. 47, no. 1, pp. 89-92, jan.-feb. 2013.
 21. Robert Olejnik, Petr Slobodian, Uroš Cvelbar, Pavel Říha, Petr Sába, "Plasma treatment as a way of increasing the selectivity of carbon nanotube networks for organic vapor sensing elements", In: Proceedings of the 1st International Conference on Materials and Applications for Sensors and Transducers, IC-MAST, May 13-17, Kos Island, Greece, *Key Eng. Mater.*, vol. 543, pp. 410-413, 2013.
 22. Elena Páslaru, Lidija Fras Zemljič, Matej Bračič, Alenka Vesel, Irena Petrinčič, Cornelia Vasile, "Stability of a chitosan layer deposited onto a polyethylene surface", *J. appl. polym. sci.*, vol. 130, iss. 4, pp. 2444-2457, Nov. 15, 2013.
 23. Zdenka Peršin, Miha Devetak, Irena Drevenšek Olenik, Alenka Vesel, Miran Mozetič, Karin Stana-Kleinschek, "The study of plasma's modification effects in viscose used as an absorbent for wound-relevant fluids", *Carbohydr. Polym.*, vol. 97, iss. 1, pp. 143-151, 14. Aug. 2013.
 24. Zdenka Peršin, Karin Stana-Kleinschek, Miran Mozetič, "The effects of storage gases on the durability of ammonia plasma effects with respect to wound fluid absorption and the biostatic activity of viscose non-wovens", *Tex. Res. J.*, pp. 1-13, Published OnlineFirst Version of Record Nov 21, 2013.
 25. Davor Peruško, M. Čizmović, Suzana Petrović, Zdravko Siketić, Miodrag Mitrić, Primož Pelicon, Goran Dražič, Janez Kovač, Velimir Milinović, Momir Milosavljević, "Laser irradiation of nano-metric Al/Ti multilayers", *Laser Phys.*, vol. 23, no. 3, pp. 036005-1-036005-7, 2013.
 26. Suzana Petrović, Bojan Radak, Davor Peruško, Primož Pelicon, Janez Kovač, Miodrag Mitrić, Biljana Gaković, Milan Trtica, "Laser-induced surface alloying in nanosized Ni/Ti multilayer structures", *Appl. Surf. Sci.*, vol. 264, pp. 273-279, 2013.
 27. Nina Recek, Morana Jaganjac, Metod Kolar, Lidija Milković, Miran Mozetič, Karin Stana-Kleinschek, Alenka Vesel, "Protein adsorption on various plasma-treated polyethylene-terephthalate substrates", *Molecules (Basel)*, vol. 18, no. 10, pp. 12441-12463, 2013.
 28. Nina Recek, Miran Mozetič, Morana Jaganjac, Lidija Milković, Neven Žarković, Alenka Vesel, "Improved proliferation of human osteosarcoma cells on oxygen plasma treated polystyrene", In: Proceeding of the JVC-14, 14th Joint Vacuum Conference, EVC-12, 12th European Vacuum Conference, AMDVG-11, 11th Annual Meeting of the German Vacuum Society, CroSloVM-19, 19th Croatian-Slovenian Vacuum Meeting, [4-8 June 2012, Dubrovnik, Croatia], *Vacuum*, vol. 98, pp. 116-121, 2013.
 29. Petr Slobodian, Pavel Říha, Robert Olejnik, Uroš Cvelbar, Petr Sába, "Enhancing effect of KMnO₄ oxidation of carbon nanotubes network embedded in elastic polyurethane on overall electro-mechanical properties of composite", *Compos. Sci. Technol.*, vol. 81, pp. 54-60, 2013.
 30. David Sojer, Irena Škulj, Spomenka Kobe, Janez Kovač, Paul J. McGuinness, "Analysis of corrosion properties of melt spun Nd-Fe-B ribbons coated by alumina coatings", *Mater. Tehnol.*, vol. 47, no. 2, pp. 223-228, mar.-apr. 2013.
 31. Tina Šetinc, Matjaž Spreitzer, Špela Kunej, Janez Kovač, Danilo Suvorov, "Temperature stable dielectric behavior of SolGel derived compositionally graded SrTiO₃/Na_{0.5}Bi_{0.5}TiO₃/SrTiO₃ thin films", *J. Am. Ceram. Soc.*, vol. 96, issue 11, pp. 3511-3517, 2013.
 32. V. Švrček, D. Mariotti, Somenath Mitra, Masao Kaneko, L. Li, Uroš Cvelbar, K. Matsubara, M. Kondo, "Built-In charges and photoluminescence stability of 3D surface-engineered silicon nanocrystals by a nanosecond laser and a direct current microplasma", *The Journal of Physical Chemistry. C, Nanomaterials and Interfaces*, vol. 117, no. 21, pp. 10939-10910948, 2013.
 33. Tina Tkavc, Alenka Vesel, Enrique Herrero Acero, Lidija Fras Zemljič, "Comparison of oxygen plasma and cutinase effect on polyethylene terephthalate surface", *J. appl. polym. sci.*, vol. 128, iss. 6, pp. 3570-3575, 2013.
 34. Andrii Vakulka, Janez Kovač, Gašper Tavčar, Tomaž Skapin, "Fluorination of mixed γ -alumina/ γ -gallia xerogels with trifluoromethane: some effects on bulk and surface characteristics", *Acta Chim. Slov.*, vol. 60, no. 3, pp. 521-536, 2013.
 35. Jelena Vasiljević, Marija Gorjanc, Brigita Tomšič, Boris Orel, Ivan Jerman, Miran Mozetič, Alenka Vesel, Barbara Simončič, "The surface modification of cellulose fibres to create super-hydrophobic, oleophobic and self-cleaning properties", *Cellulose (Lond.)*, vol. 20, no. 1, pp. 277-289, 2013.
 36. Jelena Vasiljević, Marija Gorjanc, Rok Zaplotnik, Alenka Vesel, Miran Mozetič, Barbara Simončič, "Water-vapour plasma treatment of cotton and polyester fibres", *Mater. Tehnol.*, vol. 47, no. 3, pp. 379-384, maj-jun. 2013.
 37. Aljaž Velikonja, Poornima Budime Santhosh, Ekaterina Gongadze, Mukta Vishwanath Kulkarni, Kristina Eleršič, Šárka Perutková, Veronika Kralj-Iglič, Nataša Poklar Ulrih, Aleš Iglič, "Interaction between dipolar lipid headgroups and charged nanoparticles mediated by water dipoles and ions", *Int. J. Mol. Sci. (Online)*, vol. 14, no. 8, pp. 15312-15329, 2013.
 38. Alenka Vesel, Nina Recek, Katarina Modic, "Plazemska modifikacija polimernih materialov za biomedicinske aplikacije", *Vakuumist*, vol. 33, no. 3, pp. 4-8, 2013.
 39. Alenka Vesel, Rok Zaplotnik, Miran Mozetič, "Inductively coupled oxygen plasma in H mode for removal of carbon from mixed a-C:H, W films", *Nucl. Eng. Des.*, vol. 261, 2013, pp. 275-278.
 40. Bojana Višič, Marta Klanjšek Gunde, Janez Kovač, Ivan Iskra, Janez Jelenc, Maja Remškar, "MoS₂ nanotube exfoliation as new synthesis pathway to molybdenum blue", *Mater. Res. Bull.*, vol. 48, issue 2, pp. 802-806, 2013.
 41. Bojan Zajec, Vincenc Nemanič, Marko Žumer, Corneliu Porosnicu, Cristian P. Lungu, "Hydrogen permeability through beryllium films and the impact of surface oxides", *J. Nucl. Mater.*, vol. 443, issues 1-3, pp. 185-194, nov. 2013.
 42. Rok Zaplotnik, Darij Kreuh, Alenka Vesel, "Removal of surface impurities from QCM substrates with the low-pressure oxygen-plasma treatment", *Mater. Tehnol.*, vol. 47, no. 6, pp. 795-797, 2013.
 43. Rok Zaplotnik, Alenka Vesel, Miran Mozetič, "A powerful remote source of O atoms for the removal of hydrogenated carbon deposits", *J. Fusion Energy*, vol. 32, no. 1, pp. 78-87, 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

1. Miran Mozetič, "Application of non-equilibrium gases in industry and medicine", In: *Zbornik radova: usmena predavanja, predavanja po sekcijama, usmena i poster saopštenja*, XII kongres fizičara Srbije, 28. april - 2. maj 2013, Vrnjačka Banja, Srbija, Jaroslav Labat, ed., Nikola Cvetanović, ed., Ivan Dojčinović, ed., Beograd, Društvo fizičara Srbije, 2013, pp. 103-112.

PUBLISHED CONFERENCE CONTRIBUTION

1. M. Čizmović, Janez Kovač, Momir Milosavljević, Suzana Petrović, Goran Dražič, M. Mitrić, Marko Obradović, Peter Schaaf, Davor Peruško, "Intermixing in Al/Ti multilayer structures induced by nanosecond laser pulses", In: *Proceedings of the 3rd International Conference on the Physics of Optical Materials and Devices, 26 September 2012, Belgrade, Serbia*, (Physica Scripta, Vol. T157, 2013), Stockholm, Royal Swedish Academy of Sciences, 2013, vol. 157, pp. 014008-1-014008-6, 2013.
2. Aleksander Drenik, Alenka Vesel, Miran Mozetič, Peter Panjan, "Recombination of atomic oxygen and hydrogen on amorphous carbon", In: *Proceedings of the 15th International Conference on Fusion Reactor Materials, October 16-21, 2011, Charleston, SC*, (Journal of Nuclear Materials, vol. 442, no. 1/3, suppl. 2013), Amsterdam, North-Holland, 2013, vol. 442, no. 1/3, suppl. 1, pp. S751-S754, 2013.
3. Aleksander Drenik, Pavel Yuryev, Alenka Vesel, N. Naudé, J. Margot, Richard Clergereaux, "Time evolution of instabilities in dusty magnetized ECR plasma", In: *IPICG 2013, XXXI. International Conference on Phenomena in Ionized Gases, Granada, 2013*, [S. l., s. n.], 2013, 4 str.
4. Kristina Eleršič, Aleksander Drenik, Martina Modic, Ita Junkar, Zdenka Peršin, Alenka Vesel, Uroš Cvelbar, Janez Trtnik, Karin Stana-Kleinschek, Miran Mozetič, "Extremely non-equilibrium gaseous

- plasma for sterilization of polymer materials", In: *The proceedings of the Austrian - Slovenian Polymer Meeting 2013*, Austrian - Slovenian Polymer Meeting - ASPM 2013, 3-5 April 2013, Bled, Slovenia, Majda Žigon, ed., Teja Rajšp, ed., Ljubljana, Centre of Excellence PoliMaT, 2013, pp. 178-179.
5. Ita Junkar, Martina Modic, Kristina Eleršič, Miran Mozetič, Uroš Cvelbar, Zdenka Peršin, Aleš Doliška, Karin Stana-Kleinschek, "Platelet morphology and adhesion on functionalized surfaces", In: *The proceedings of the Austrian - Slovenian Polymer Meeting 2013*, Austrian - Slovenian Polymer Meeting - ASPM 2013, 3-5 April 2013, Bled, Slovenia, Majda Žigon, ed., Teja Rajšp, ed., Ljubljana, Centre of Excellence PoliMaT, 2013, pp. 183-184.
 6. K. Kutasi, Rok Zaplotnik, Gregor Primc, Miran Mozetič, "Controlling the oxygen species density distribution in the flowing afterglow of an O₂ surface-wave microwave discharge", In: *IPCIG 2013, XXXI. International Conference on Phenomena in Ionized Gases*, Granada, 2013, [S. l., s. n.], 2013, 4 pp.
 7. Miran Mozetič, Nina Recek, Morana Jaganjac, Lidija Milkovič, Neven Žarković, Alenka Vesel, "Adsorption of proteins and cell adhesion to plasma treated polymer substrates", In: *ECASIA'13*, 15th European Conference on Applications of Surface and interface Analysis, 13-18 October, Cagliari, Sardinia, Ital, B. Elsener, Antonella Rossi, ed., Cagliari, Dipartimento di Scienze Chimiche e Geologiche, Università di Cagliari, 2013, pp. 406.
 8. M. Oberkofler *et al.* (25 authors), "First nitrogen-seeding experiments in JET with the ITER-like Wall", In: *Proceedings of the 20th International Conference on Plasma-Surface Interactions in Controlled Fusion Devices, 21-25 May, 2012, Aachen, Germany*, (Journal of nuclear materials, vol. 438, suppl. 2013), Sebastijan Brezinšek, ed., Amsterdam, North-Holland, 2013, vol. 438, suppl., pp. S258-S261, 2013.
 9. Nina Recek, Miran Mozetič, Alenka Vesel, "Obdelava polimernih podlag z nizkotlačno kisikovo plazmo za boljše vezavo malignih človeških kostnih celic", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 357-365.
 10. Jelena Vasiljević, Marija Gorjanc, Brigita Tomšič, Boris Orel, Ivan Jerman, Miran Mozetič, Alenka Vesel, Barbara Simončič, "Surface modification of polyester fibres by plasma pretreatment and sol-gel finishing", In: *Conference proceedings*, 13th Autex Conference, May 22-24, 2013, Dresden, Germany, Dresden, Technische Universität Dresden, ITM, 2013, 6 f.
 11. Alenka Vesel, Mitja Kolar, Karin Stana-Kleinschek, Miran Mozetič, "Comparison of etching rates of model proteins, blood plasma and PET polymer in oxygen afterglow", In: *ECASIA'13*, 15th European Conference on Applications of Surface and interface Analysis, 13-18 October, Cagliari, Sardinia, Ital, B. Elsener, Antonella Rossi, ed., Cagliari, Dipartimento di Scienze Chimiche e Geologiche, Università di Cagliari, 2013, pp. 445.
 12. Alenka Vesel, Miran Mozetič, Marianne Balat-Pichelin, "Reaction of oxygen plasma with hydrogenated W-C deposits", In: *Proceedings*, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 1401-1-1401-9.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Marija Gorjanc, Marija Gorenšek, P. Jovančič, Miran Mozetič, "Multifunctional textiles - modification by plasma, dyeing and nanoparticles", In: *Eco-friendly textile dyeing and finishing*, Melih Günay, ed., Rijeka, InTech, 2013, pp. [3]-31.
2. Uroš Maver, Tina Maver, Zdenka Peršin, Miran Mozetič, Alenka Vesel, Miran Gaberšček, Karin Stana-Kleinschek, "Polymer characterization with the atomic force microscope", In: *Polymer science*, Faris Yilmaz, Rijeka, InTech, cop. 2013, pp. 113-132.
3. Zdenka Peršin, Miran Mozetič, Alenka Vesel, Tina Maver, Uroš Maver, Karin Stana-Kleinschek, "Plasma induced hydrophilic cellulose wound dressing", In: *Cellulose - medical, pharmaceutical and electronic applications*, Theo Van de Ven, ed., Louis Godbout, ed., Rijeka, InTech, cop. 2013, pp. 163-194.

DEPARTMENT OF SOLID STATE PHYSICS

F-5

Our research program is focused on studying the structure and dynamics of disordered and partially ordered condensed matter at the atomic and molecular levels, with a special emphasis on phase transitions. The purpose of these investigations is to discover the basic laws of physics governing the behavior of these systems, which represent the link between perfectly ordered crystals, on one side, and amorphous matter, soft condensed matter and living systems, on the other. Such knowledge provides the key to our understanding of the macroscopic properties of these systems and is an important condition for the discovery and development of new multifunctional materials, nanomaterials and biomaterials for new applications. An important part of the research program is devoted to the development of new experimental methods and techniques in the field of magnetic resonance, magnetic resonance imaging, fluorescence microspectroscopy, scanning tunneling, electronic and atomic force microscopy, as well as dielectric relaxation spectroscopy and dynamic specific heat measurements.



Head:

Prof. Igor Muševič

The experimental techniques used are:

- One (1D) and two (2D) dimensional nuclear magnetic resonance (NMR) and relaxation, as well as quadrupole (NQR) resonance and relaxation,
- Multi-frequency NMR in superconducting magnets of 2T, 6T and 9T, as well as the dispersion of the spin-lattice relaxation time T_1 via field cycling,
- Nuclear double resonance and quadrupole double resonance such as ^{17}O -H and ^{14}N -H,
- Fast field cycling NMR relaxometry,
- Frequency-dependent electron paramagnetic resonance (EPR) and 1D and 2D pulsed EPR and relaxation
- MR imaging and micro-imaging
- Measurement of the electronic transport properties
- Magnetic measurements.
- Fluorescence microscopy and microspectroscopy
- Linear and non-linear dielectric spectroscopy in the range 10^{-2} Hz to 10^9 Hz,
- Electron microscopy and scanning tunnelling microscopy,
- Atomic force microscopy and force spectroscopy,
- Dynamic specific-heat measurements.

The research program of the Department of Solid State Physics at the Jožef Stefan Institute is performed in close collaboration with the Department of Physics at the Faculty of Mathematics and Physics of the University of Ljubljana, Institute of Mathematics, Physics and Mechanics and the Jožef Stefan International Postgraduate School. In 2013, the research was performed within three research programs:

- Magnetic Resonance and Dielectric Spectroscopy of Smart New Materials
- Physics of Soft Matter, Surfaces and Nanostructures
- Experimental Biophysics of Complex Systems

I. Research programme “Magnetic resonance and dielectric spectroscopy of smart new materials”

The research of the programme group has focused on a study of the physical phenomena in condensed matter at the atomic and molecular levels. The purpose of the investigations was to discover the basic laws of physics governing the behaviour of the investigated systems. The attained knowledge provides the key to the understanding of microscopic and macroscopic properties of various types of solids and is an important condition

The group has investigated important open issues in the electronic properties of quasicrystals and complex metallic alloys, quantum magnetism in low-dimensional spin systems, the physical properties of nanostructures, materials with a giant electrocaloric and thermomechanical effect, and multiferroic and relaxor phases. The research included pharmaceutical and biological substances, where a nuclear quadrupole resonance-based technique for the detection of nitrogen complexes (as found in explosives, drugs and narcotics) was developed.

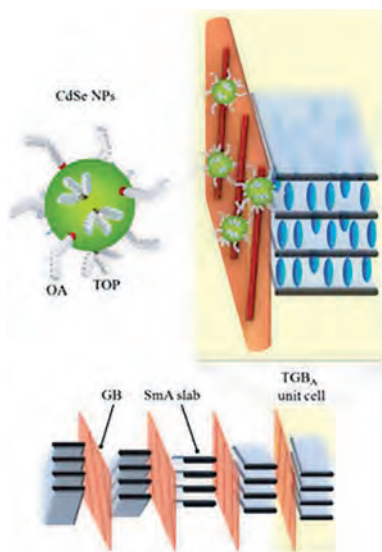


Figure 1: Structure of the TGB_A phase and trapping of nanoparticles within the cores of defect lines, thus helping to stabilize the screw dislocations.

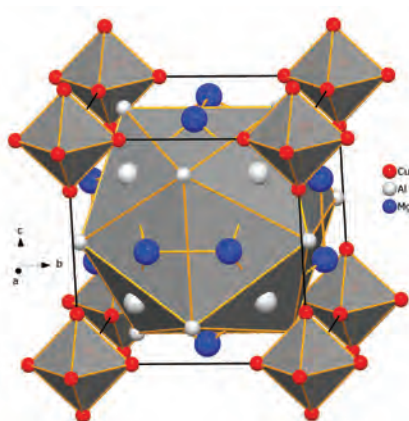


Figure 2: Motif from the crystal structure of the cubic metallic phase V-Al₅Cu₆Mg₂.

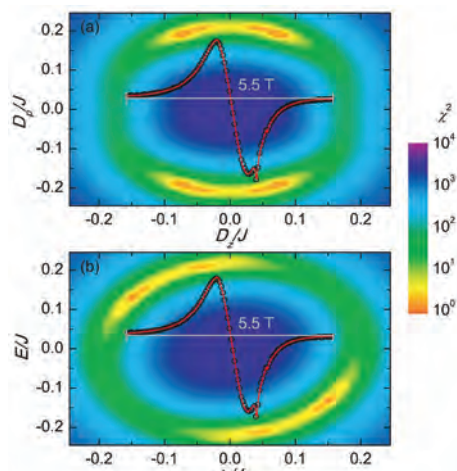


Figure 3: Determination of the magnetic anisotropy parameters of the quantum kagome antiferromagnet BaCu₃V₂O₈(OH)₂ in the case of (a) crystal-field anisotropy and (b) Dzyaloshinsky-Moriya anisotropy.

for the discovery and development of new multifunctional materials and nanomaterials for novel technological applications.

Study of the critical properties of nanostructured materials and materials with large electrocaloric and thermomechanical effects

Using direct measurements it was shown that the maximum electrocaloric response is achieved at the ferroelectric phase-transition temperature. Field-dependent piezoelectric measurements have demonstrated in BaTiO₃ that the field-induced critical point influences the strength of the electromechanical response and the electrocaloric responsivity, both of which exhibit a maximum in the vicinity of the critical point. Using calorimetric and optical experiments we showed that the anisotropic graphene and MoS₂ nanoparticles stabilize the first blue phase in contrast to spherical nanoparticles, which mainly stabilize the third blue phase. Moreover, CdSe spherical quantum dots stabilize the TGB_A phase (see Figure 1), which is an analogue of the Shubnikov phase of type-II superconductors. The above results have been published in 14 articles in international scientific journals. Recently published works on electrocalorics and the stabilization of blue phases have been cited more than 100 times in 2013 alone.

Complex metallic alloys

Combining the measurements of bulk transport properties, specific heat and nuclear magnetic resonance, the group of Janez Dolinšek studied the influence of structural complexity on the physical properties of the cubic intermetallic phase V-Al₅Cu₆Mg₂. With 39 atoms in a unit cell, V-Al₅Cu₆Mg₂ is an intermetallic phase with an intermediate structural complexity (Figure 2). We found that the free-electron approximation provides a good description of the V-Al₅Cu₆Mg₂ behaviour, despite the presence of the quenched structural disorder at low temperatures, which is very likely intrinsic to the structure of V-Al₅Cu₆Mg₂. The work was published in M. Klanjšek, S. Jazbec, M. Feuerbacher, J. Dolinšek, "Physical properties of the V-Al₅Cu₆Mg₂ complex intermetallic phase", *Intermetallics* 39, 50 (2013).

Quantum magnetism

By means of neutron scattering and specific heat measurements, Martin Klanjšek, with French colleagues, studied the magnetic ordering of the quasi-one-dimensional antiferromagnet BaCo₂V₂O₈ at low temperatures in magnetic fields up to 12 T. They confirmed the theoretically predicted incommensurate magnetic ordering in fields above 3.9 T and showed that two types of magnetic domains with equal populations develop in the material. They determined the critical exponents for the transitions into the Néel and incommensurate magnetic ordered state. The work was published in E. Canévet, B. Grenier, M. Klanjšek et al., "Field-induced magnetic behavior in quasi-one-dimensional Ising-like antiferromagnet BaCo₂V₂O₈: a detailed single-crystal neutron diffraction study", *Phys. Rev. B* 87, 054408 (2013).

By means of ¹³³Cs nuclear magnetic resonance and electron paramagnetic resonance, Denis Arčon, Kristijan Anderle and Martin Klanjšek, with German colleagues, studied the coupling between the electron, lattice, orbital and spin degrees of freedom in the p-electron compound Cs₄O₆. They realized that the temperature evolution of the measured spectra depends dramatically on the thermal history of the sample. The compound exhibits two competing low-temperature phases, the quenched cubic phase and the low-symmetry phase, where the portion of each phase depends on the cooling protocol. This interesting result is a consequence of the slow reorientation of the p orbitals on cooling. The work was published in D. Arčon, K. Anderle, M. Klanjšek et al., "Influence of O₂ molecular orientations on p-orbital ordering and exchange pathways in Cs₄O₆", *Phys. Rev. B* 88, 224409 (2013).

Matej Pregelj, Andrej Zorko and coworkers studied the origin of the magnetic anisotropy in the {Cu₄(tetrenH₅)[W(CN)₈]·7.2H₂O}_n system. Their results revealed that two-dimensional magnetic correlations start to develop already at 70 K, i.e., well above the magnetic ordering transition. Their modelling of the experimental results shows that the key to the anisotropic response lies within the combination of the dipolar interaction and the axial local anisotropy of the W and Cu ions. Their results were published in O. Zaharko *et al.*, "Source of magnetic anisotropy in quasi-two-dimensional XY {Cu₄(tetrenH₅)[W(CN)₈]·7.2H₂O}_n", *Phys. Rev. B* 87, 024406 (2013).

Andrej Zorko, Matej Pregelj, Anton Potočnik, Denis Arčon and collaborators determined the magnetic structure in the ground state of the spin-chain system CuSe₂O₅. This is characterized by

staggered moments with significantly reduced size, as a consequence of quantum fluctuations. By employing various complementary experimental techniques we also determined the magnetic anisotropy of the system, which is responsible for the staggering of the moment as well as for a relatively small critical field, leading to a spin-flop magnetic transition. Their results were published in M. Herak *et al.*, "Magnetic order and low-energy excitations in the quasi-one-dimensional antiferromagnet CuSe_2O_5 with staggered fields", *Phys. Rev. B* 87, 104413 (2013).

Utilizing electron spin resonance, Andrej Zorko and collaborators determined the magnetic anisotropy of the quantum kagome antiferromagnet $\text{BaCu}_3\text{V}_2\text{O}_8(\text{OH})_2$ and showed that this is of the Dzyaloshinsky-Moriya type (Figure 3). They demonstrated that its dominant component is perpendicular to the kagome planes, which significantly suppressed the quantum fluctuations in this system. Freezing of the fluctuations is responsible for the unexpected long-range magnetic ordering of this system at relatively high temperatures, comparable to the exchange interactions. Their results were published in A. Zorko *et al.*, "Dzyaloshinsky-Moriya interaction in vesignieite: a route to freezing in a quantum kagome antiferromagnet", *Phys. Rev. B* 88, 144419 (2013).

Multiferroics

Matej Pregelj, Peter Jeglič, Andrej Zorko, Tomaž Apih, Anton Gradišek, Denis Arčon and coworkers studied magnetically ordered states and the accompanying structural changes in the multiferroic $\text{FeTe}_2\text{O}_5\text{Br}$ (Figure 4). Employing a combination of neutron diffraction and nuclear quadrupolar resonance (NQR) they managed to determine the incommensurate magnetic ordering in the paraelectric state (HT-IC), which exists in a narrow temperature range – just a few Kelvins before the multiferroic state (LT-IC) with finite electric polarization. In addition, they confirmed that electric polarization stems from the magnetostriction of Fe-O-Te-O-Fe exchange pathways, which is related to the phase shifts of the neighbouring magnetic modulation waves. Their results were published in M. Pregelj *et al.*, "Evolution of magnetic and crystal structures in the multiferroic $\text{FeTe}_2\text{O}_5\text{Br}$ ", *Phys. Rev. B* 87, 144408 (2013).

As a continuation of the work on the $\text{FeTe}_2\text{O}_5\text{X}$, $\text{X} = \text{Br}, \text{Cl}$ system, Matej Pregelj, Andrej Zorko, Peter Jeglič, Zdravko Kutnjak, Simon Jazbec and Denis Arčon with coworkers studied the magnetic, structural and dielectric properties of the $\text{FeTe}_2\text{O}_5\text{Cl}$ compound. They have discovered that its ground state is multiferroic and that the corresponding magnetic ordering is very similar to the one in the isostructural $\text{FeTe}_2\text{O}_5\text{Br}$ system (Figure 5). They also learned that the main difference between the two isostructural compounds is in the structural effects, accompanying the establishment of the multiferroic phase, which are much more pronounced in $\text{FeTe}_2\text{O}_5\text{Cl}$. Moreover, they assigned these structural changes to the shift of the O_1 ion and correlated them with the polarization of the Te^{4+} lone-pair electrons. In this way they confirmed that the lone-pair electrons are indeed the carriers of the electric polarization in these systems. Their results were published in M. Pregelj *et al.*, "Multiferroicity in the geometrically frustrated $\text{FeTe}_2\text{O}_5\text{Cl}$ ", *Phys. Rev. B* 88, 224421 (2013).

Clathrates

In collaboration with Prof. Tanigaki from Japan, Denis Arčon, Andrej Zorko and Peter Jeglič studied type-I germanium clathrates – cage structures with promising thermoelectric properties. Their NMR results are in agreement with claims that the conventional picture of purely ionic interactions between the rattling guest atoms and the cage is only approximate and that covalent effects should be taken into account in the clathrates or similar thermoelectric cage materials. Their results were published in A. Arčon *et al.*, "Rattler site selectivity and covalency effects in type-I clathrates", *J. Phys. Soc. Jpn.* 82, 014703 (2013).

Studies of crystal structures

Matej Pregelj and coworkers studied copper and zinc complexes with the condensation derivative of 2-acetylpyridine and hydrolyzed ethyl hydrazinoacetate. They determined the crystal structure and discovered that the fifth coordination site of the ligand (Zn/Cu) is occupied by a chloride, causing a distortion of the zinc surrounding. In addition, they studied thermal behaviour employing thermogravimetric analysis. Their results were published in N. Filipović *et al.*, "Synthesis, characterization, and thermal behavior of Cu(II) and Zn(II) complexes with (E)-2-[N-(1-pyridin-2-yl-ethylidene)hydrazino]acetic acid (aphaOH), Crystal structure of $[\text{Zn}_2(\text{aphaO})_2\text{Cl}_2]$ ", *J. Coord. Chem.* 66, 1549 (2013).

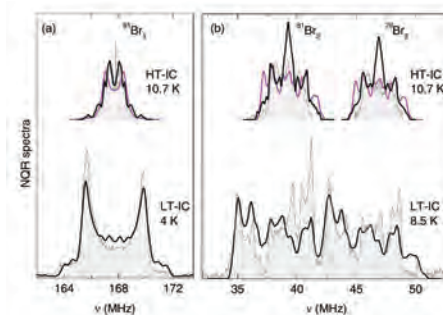


Figure 4: The ^{81}Br NQR spectra for (a) Br_1 and (b) for both isotopes of Br_2 in the high-temperature (HT-IC) and the low-temperature (LT-IC) phases. Thick black lines are simulations considering the magnetic structures determined by neutron diffraction and the derived hyperfine coupling tensors. For a comparison we show simulations of the HT-IC spectra based on the LT-IC structure with an appropriately reduced size of the magnetic moments (thick magenta line).

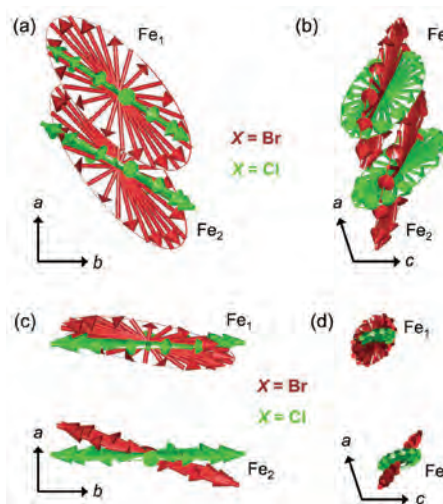


Figure 5: Magnetic structure models for $\text{FeTe}_2\text{O}_5\text{X}$ ($\text{X} = \text{Br}, \text{Cl}$), compared at Fe_{11} and Fe_{21} sites for the low-temperature phase in the (a) ab and (b) ac projections, and for the high-temperature phase in the (c) ab and (d) ac projections. For clarity, the magnetic unit cell along b is flattened and the sizes of the magnetic moments in (c) and (d) are magnified by a factor of 3.

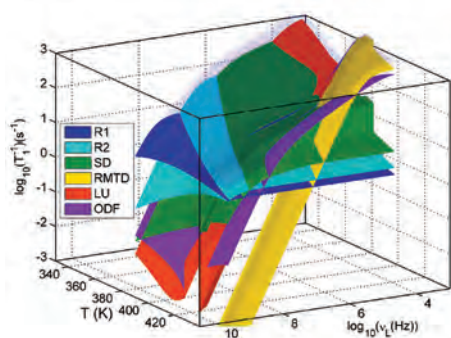


Figure 6: Contributions of various dynamic processes to the total proton relaxation as a function of temperature and magnetic field.

Zeolites

In collaboration with Prof. Igarashi and Prof. Nakano from Japan, Peter Jeglič and Denis Arčon studied alkali-doped zeolites. Zeolites are nanoporous materials with periodic nanospaces (known as cages), which can accommodate a large amount of alkali atoms. For low-doping levels with sodium atoms the low-silica X zeolites are insulating, whereas they become metallic for high-doping levels. The confined geometry of the alkali-metal nanoclusters imposed by the framework cages make enhanced coupling between the electronic and lattice degrees of freedom leading to the formation of polaron states. The ^{23}Na and ^{27}Al nuclear magnetic resonance (NMR) investigation of low-silica X zeolites suggests strong electron-phonon coupling in support of the proposed polaron model. This work is described in the paper M. Igarashi, T. Nakano, P. T. Thi, Y. Nozue, A. Goto, K. Hashi, S. Ohki, T. Shimizu, A. Krajnc, P. Jeglič and D. Arčon, "NMR study of thermally activated paramagnetism in metallic low-silica X zeolite filled with sodium atoms", *Phys. Rev. B* 87, 075138 (2013).

Molecular dynamics in a blue phase liquid crystal: a 1H fast field-cycling NMR relaxometry study

Liquid crystals exhibiting blue phases are attractive systems to study due to their highly interesting properties in the fields of optics and photonics. We investigated molecular dynamics in a chiral system, called 10BBL, that exhibits blue phase (BP), two twisted grain-boundary phases (TGB), and a smectic C (SmC^*) phase. All these phases are stable over large temperature ranges. By means of fast field-cycling NMR relaxometry, we measured the temperature and field dependencies of proton spin-lattice relaxation times. Using theoretical models for different dynamic processes, we determined correlation times, activation energies, etc. for these processes, which include molecular rotations/reorientations, order director fluctuations, layer undulations, self-diffusion, and rotations mediated by translational diffusion along the helical axis (Figure 6). This is the first relaxometric study of a blue phase liquid crystal, published by Anton Gradišek, Tomaž Apih, Valentina Domenici, Vladimira Novotna, Pedro J. Sebastião, in *Soft Matter*, 2013,9, 10746-10753.

NMR study of molecular dynamics in complex metal borohydride $\text{LiZn}_2(\text{BH}_4)_5$

Lithium zinc borohydride $\text{LiZn}_2(\text{BH}_4)_5$ (LZBH) was investigated as a potentially interesting hydrogen-storage material due to its high hydrogen content and low decomposition temperature. LZBH shows a structure of two identical interpenetrated three-dimensional frameworks with no bonds between them, which is a unique feature in complex metal hydrides. To better understand the relations between the structure and the thermodynamics of the system, we studied molecular dynamics in LZBH by means of ^1H and ^7Li NMR spectra and spin-lattice relaxation measurements. Different thermally activated re-orientational processes of BH_4^- tetrahedra about their 2-fold and 3-fold symmetry axes were identified from the temperature-dependent proton and lithium spin-lattice relaxation rates and were quantified by their activation energies. Due to the structure, there are two different types of BH_4^- tetrahedra; one type is located between two Zn atoms and the other type between one Li and one Zn atom. Our study presents a physical insight into the dynamic properties of LZBH on the microscopic level of atomic groups, providing a link between the microscopic and the bulk properties of this phase. Published by Anton Gradišek, Dorthe B. Ravnsbæk, Stanislav Vrtnik, Andraž Kocjan, Janez Lužnik, Tomaž Apih, Torben R. Jensen, Alexander V. Skripov, Janez Dolinšek, in *J. Phys. Chem. C*, 2013, 117, 21139–2147.

Nanomaterials

Tungsten oxide nanostructures functionalized with gold or platinum NPs were synthesized and integrated, using a single-step method via aerosol-assisted chemical vapour deposition, onto micro-electromechanical system (MEMS)-based gas-sensor platforms. This co-deposition method is demonstrated to be an effective route to incorporate metal NPs or combinations of metal NPs into nanostructured materials, resulting in an attractive way of tuning the functionality in metal oxides. The results show variations in the electronic and sensing properties of tungsten oxide according to the metal NPs introduced, which are used to discriminate effectively analytes ($\text{C}_2\text{H}_5\text{OH}$, H_2 , and CO) that are present in proton-exchange fuel cells. Improved sensing characteristics, in particular to H_2 , are observed at 250 °C with Pt-functionalized tungsten oxide films, whereas non-functionalized tungsten oxide films show responses to low concentrations of CO at

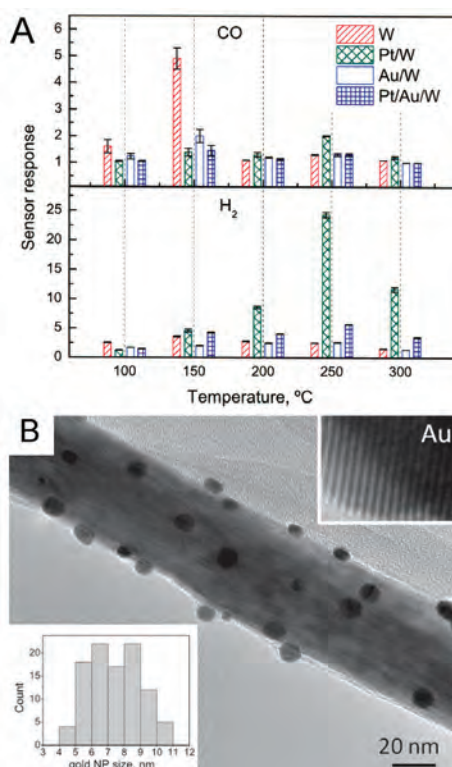


Figure 7: A) Sensor responses and error bars to 100 ppm of CO and 100 ppm of H_2 as a function of the operating temperature; B) TEM image of WO_3 nanostructure functionalized with Au nanoparticles. Inset on the bottom left side shows the size distribution of the Au nanoparticles. Label L stands for WO_3 nanostructures, while labels Pt/W, Au/W in Pt/Au/W denote nanostructures decorated with Pt, Au and Pt/Au nanoparticles.

low temperatures. This work was published in several articles by Polona Umek et al., among others in *Advanced Functional Materials* 23, 1313-1322 (2013).

Substituted imidazole and benzimidazole often form polar hydrogen-bonded chains in the solid state. 2-Methylbenzimidazole is known to be a high-temperature organic ferroelectric. We have measured the temperature dependences of ^{14}N nuclear quadrupole resonance (NQR) frequencies and proton T_1 in 2-methylbenzimidazole and 5,6-dimethylbenzimidazole. The NQR frequencies are assigned to amino and imino nitrogen positions. The NQR data exclude the possibility of proton two-site exchange in an N-H...N hydrogen bond. The activation energies for the methyl group hindered rotation are determined in both compounds. The present ^{14}N NQR data are compared to the published ^{14}N NQR data in solid-substituted and coordinated imidazoles, in substituted benzimidazoles and in imidazole in the gas phase. A linear correlation between the two in-plane principal values of the quadrupole coupling tensor and the out-of-plane principal value of the quadrupole coupling tensor is observed in imidazole, ranging from the amino nitrogen position to the imino nitrogen position. The transition from the amino to the imino nitrogen position is determined on the correlation diagram. The correlation diagram can be used to quantitatively observe the asymmetry of the N-H...N hydrogen bond. A similar correlation diagram is also proposed for substituted benzimidazoles. The magnitudes of the principal values of the ^{14}N quadrupole coupling tensor in ferroelectric 2-methylbenzimidazole show that the macroscopic ferroelectric ordering has, in this compound, a minor effect on the asymmetry of the N-H...N hydrogen bonds.

Pharmaceutical and biological substances

^{14}N nuclear quadrupole resonance frequencies have been measured in solid 2-pyridone, 3-hydroxypyridine, and 4-pyridone by ^1H - ^{14}N nuclear quadrupole double resonance. Two slightly non-equivalent nitrogen positions are observed in solid 3-hydroxypyridine, whereas only one nitrogen position has been observed in 2-pyridone and 4-pyridone within the experimental resolution. The rather low ^{14}N quadrupole coupling constants in pyridones are the consequence of the delocalization of the nitrogen lone-pair electrons in the aromatic rings. Two different compounds have been obtained by the crystallization of 4-pyridone from ethanol in a normal and in a dry atmosphere. The compound obtained in the dry atmosphere is identical to the commercial sample. The compound obtained in the normal atmosphere cannot be converted to the commercial polymorph by melting. It is thus not a polymorph of anhydrous 4-pyridone. The temperature coefficient of the ^{14}N quadrupole coupling constant is negative in 3-hydroxypyridine and positive in 2- and 4-pyridone. Therefore, in 3-hydroxypyridine, molecular librations dominate the temperature variation of the quadrupole coupling constant, whereas in 2- and 4-pyridone, the changes in the hydrogen bonding interactions with temperature seem to give the dominant effect.

Co-crystals and crystal polymorphs

The ^{14}N and ^{17}O nuclear quadrupole resonance frequencies have been measured in 1:1 co-crystals and salts of 2-amino-4,6-dimethylpyrimidine and several carboxylic acids. A systematic decrease in the ^{17}O quadrupole coupling constant with the increasing strength of the hydrogen bond is observed in co-crystals bound by O-H...N hydrogen bonds. The O-H distances deduced from the line widths of the ^{17}O NQR lines show that the hydrogen atom is in a hydrogen bond formed by a carboxylic groups for about 0.01 nm displaced from the oxygen atom toward the centre of the hydrogen bond. In the O-H...N hydrogen bond formed by the hydroxyl group, which is only slightly longer than the hydrogen bonds formed by the carboxyl group, the hydrogen atom is much less displaced. A linear relation between the ^{14}N quadrupole coupling constant and the sum of the inverse third powers of the H...A (A = O or N) distances is deduced for the amino group. A linear correlation of the principal values of the ^{14}N quadrupole coupling tensor in NH_2 , as observed in the solid phase and in the gas phase, is analysed in a simple model assuming a displacement of the electron charge in the N-H σ bond and simultaneous deformation of the nitrogen lone-pair electron orbital. At the ring nitrogen position, hydrogen bonding and proton transfer produce a large decrease in the ^{14}N quadrupole coupling constant. A linear correlation of the principal values of the ^{14}N quadrupole coupling tensor is observed in co-crystals and salts of 2-amino-4,6-dimethylpyrimidine. This correlation differs from the correlation observed in substituted pyrimidine, where the hydrogen atoms are replaced by other atoms or functional groups. The difference is analysed in a model, which assumes that the hydrogen bonding and substituents affect the nitrogen lone pair and π electron orbitals. The analysis shows that the two effects are nearly independent. The application of ^{14}N NQR to the study of co-crystals and crystal polymorphs is reviewed. In ferroelectric and antiferroelectric organic co-crystals ^{14}N NQR is used to determine the proton position in an N-H...O hydrogen bond and the proton displacement below T_c . In co-crystal isonicitinamide - oxalic acid (2:1) ^{14}N NQR is used to distinguish between the two polymorphs and to determine the type of the hydrogen bond (N...H-O). The difference in the ^{14}N NQR spectra of the co-crystal formers and the co-crystal is investigated in the case of carbamazepine, saccharin and carbamazepine-saccharin (1:1). The experimental resolution allows an unambiguous distinction between the ^{14}N NQR spectrum of the co-crystal and the ^{14}N NQR spectra of the co-crystal formers. The possibility of the application

of NQR and the double resonance for the determination of the inhomogeneity of the sample and for the study of the lifetime of an unstable polymorph is discussed.

Amorphous solids

Nuclear quadrupole double resonance (NQDR) is proposed as a method for the quantitative observation of crystallization of amorphous solids. NQDR signals from amorphous and crystalline parts of a sample may be separated. The intensity I of the NQDR signal from the crystalline part of the sample is proportional to its mass. With increasing time the amorphous phase in the sample transforms to the crystal phase and the intensity I approaches its limiting value I_0 , corresponding to a complete transformation to the crystal phase. The ratio I/I_0 is equal to the mass fraction of the crystalline part of the sample. The same experimental method can be used to determine the mass fraction of a given crystal polymorph in a mixture of crystal polymorphs. As an example we studied the crystallization of amorphous nifedipine at 100 °C. The results of the NQDR study are compared to the published results of other studies.

Impact of structure modifications on electrically induced properties of relaxor polymers

In collaboration with researchers from Pennsylvania State University, USA, we have investigated how the dielectric, electromechanical, and electrocaloric properties of ferroelectric and relaxor polymers (systems that exhibit fast response speeds, giant electrostriction, high electric energy density, and large electrocaloric effect) are affected by various processing procedures and/or modifications, such as (i) stretching the relaxor polymer, (ii) irradiating the ferroelectric polymer with high-energy electrons, and (iii) blending a relaxor polymer with the ferroelectric system. We have recently focused on the P(VDF-TrFE) copolymer that is irradiated with low and moderate doses of high-energy electrons - up to now most of investigations have focused either on ferroelectric P(VDF-TrFE) copolymer or P(VDF-TrFE) that is irradiated with high doses and is thus completely transformed into a relaxor system. Using various experimental techniques we found clear evidence that in such a case ferroelectric and relaxor states coexist in the system, which was a key point for the explanation of their enhanced electrocaloric response. Particularly for the nonlinear dielectric spectroscopy (Figure 8) - we have in fact conducted the first measurements of the real and imaginary parts of the nonlinear dielectric response in ferroelectric and relaxor polymers - was found as an extremely powerful tool for investigating the correlation between the structure and the property evolution in relaxor polymer systems. Published in: G. Casar, X. Li, J. Koruza, Q. M. Zhang, V. Bobnar. Electrical and thermal properties of vinylidene fluoride-trifluoroethylene-based polymer system with coexisting ferroelectric and relaxor states. *J. Mater. Sci.* 48, 7920 (2013).

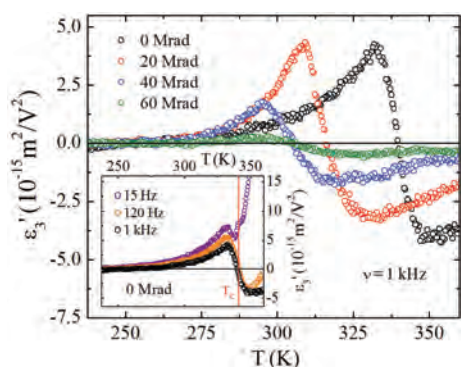


Figure 8: The nonlinear dielectric response revealed the coexistence of ferroelectric and relaxor states in P(VDF-TrFE) copolymer, irradiated with low doses of high-energy electrons, which was a key point for the explanation of their enhanced electrocaloric response.

High-temperature dielectric investigations of a novel inorganic relaxor system

We have continued high-temperature dielectric investigations of classical inorganic relaxors, which revealed astonishing results - they contradict widely the accepted dogmas on relaxor properties. Also the results obtained in a novel $\text{Pb}(\text{Sc}_{1/2}\text{N}_{1/2})\text{O}_3$ ceramic system, prepared from mechanochemically activated powder, clearly reveal that the polar nanoregions do not form at the so-called Burns temperature (approx. 600 K), but are continuously formed over a broad temperature range, starting well above 800 K. We have in fact successfully recognized various distinctive dielectric contributions in a broad temperature range of 150–750 K. Moreover, a detailed analysis of the intrinsic high-temperature dielectric response revealed a critical behaviour associated with universality classes typically found in spin glasses and, particularly, that the low-temperature fingerprint behaviour can be observed at much higher temperatures, well above the dispersive relaxor dielectric maximum.

Published in: V. Bobnar, H. Uršič, G. Casar, S. Drnovšek. Distinctive contributions to dielectric response of relaxor ferroelectric lead scandium niobate ceramic system. *Phys. Status Solidi B* 250, 2232 (2013).

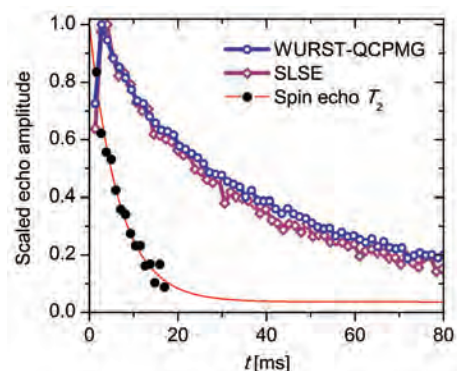


Figure 9: The decay of echo amplitudes during the SLSE experiment with rectangular pulses and QCPMG experiment with WURST pulses. For comparison also the T_2 decay is shown. The sensitivity of each experiment is here roughly proportional to the area below the curves. Published in: A. Gregorovič, T. Apih, *J. Mag. Res.* 233, 96 (2013).

“WURST-QCPMG sequence and “spin-lock” in 14-N Nuclear Quadrupole Resonance”

The excitation of magnetization in Nuclear Quadrupole Resonance (NQR) is most often accomplished with the use of rectangular RF pulses, where the pulse amplitude and phase are constant during the pulse. These pulses are technically easy to implement. Also, they are easy to include in various theoretical predictions and analysis. However, rectangular pulses also have some disadvantages. When these disadvantages become severe, shaped pulses are often used instead. Here, the amplitude and phase during the pulse follow a prescribed function. WURST pulses are

just one of the many shaped pulses and are in use in NMR for a decade. Their principal advantage is a large excitation bandwidth at low RF powers. In the publication we demonstrate that WURST pulses are suitable for ^{14}N NQR as well. In particular, we demonstrate, that the “spin-lock” effect is completely preserved compared to rectangular pulses. This is very important, as the spin-lock effect is essential for the ^{14}N NQR detection. It allows us to increase the otherwise poor sensitivity by 10-100 times (Figure 9). The theoretical prediction/analysis of the spin-lock effect is already challenging for the rectangular pulses. For shaped pulses it would be even more difficult. Thus the existence of the spin-lock effect for WURST pulses is not at all obvious. In the publication we have shown how the WURST pulses combined with the QCPMG sequence can significantly reduce the time required for the acquisition of a very broad ^{14}N spectrum, usually a very time-consuming task. In addition, WURST pulses require limited RF power, and are as such appropriate for small desktop applications of ^{14}N NQR.

II. Research programme “Physics of Soft Matter, Surfaces, and Nanostructures”

The investigations of the research program “Physics of Soft Matter, Surfaces, and Nanostructures” are focused on novel complex soft matter systems and surfaces with specific functional properties. We investigated in particular liquid crystalline elastomers and dendrimers as novel multifunctional materials, nematic colloids, molecular motors, soft-matter photonic crystals and novel synthetic or self-assembled micro- and nanostructures. The aim of the program is to understand structural and dynamical properties of these systems, their interactions, their function at the molecular level, and self-assembly mechanisms in soft matter. The underlying idea is that it is possible to understand complex mechanisms, such as self-assembly, on a macroscopic level, using a simplified physical picture and models. In order to provide a comprehensive approach to the problem, the program combines both experimental and theoretical investigations, supported by modelling and simulations. Special emphasis is given to the possible electro-optic and medical applications.

We have investigated the topology and photonics of liquid-crystal colloids and dispersions, and studied the motion of molecular motors. New nanocomposite materials have been developed, the structure of matter has been studied on the atomic level and a new infrastructure for cold atom physics experiments was set up.

Highly constrained topological defects in nematics

Topological defects in uniaxial nematics can be compared to the defects in biaxial media. The defects are not equivalent, but similarities can be exploited to better understand the topological rules that govern the disclinations in uniaxial nematics. Disclination lines with variable profiles are systematically described with quaternions, which allow the simple characterization of disclinations by counting geometrically recognizable features (Čopar and Žumer, PRSA 469, 2013). In a similar fashion, the bulk director, away from the defects, can be studied as a biaxial phase by using its derivatives. This formulation finds “quasi-disclinations” that carry additional topological information, potentially useful for a description of the blue phases and general chiral nematics (Čopar et al, PRE 87, 2013).

3D nematic colloidal crystals

Significant advancements have been made in our understanding of assembling 3D nematic colloidal crystals. We have published in *Nature Communications* (Nych et al, Nature Commun. 4, 2013) an article about the laser-tweezers-assisted assembly of 3D nematic colloidal crystals from dipolar nematic colloids. Using fluorescent confocal microscopy we have found that the unit cell of this 3D crystal is tetragonal with a basis (Figure 10). This crystal shows unusual response to external electric fields; for positive dielectric anisotropy of the nematic liquid crystal, the crystal shrinks up to 30%. If the dielectric anisotropy of the carrier nematic liquid crystal is negative, then the colloidal crystal rotates as a solid unit. The angle of rotation is up to several tens of degrees.

Nematic colloids

In nematic colloids, advances have been seen in a systematic numerical and theoretical study of disclination networks in the interstitial space of a close-packed lattice of homeotropic particles has revealed a model (Figure 11) that explains the reconfigurable interconnected defects in simplest geometric terms. Local description using tetrahedra and cubes is used to construct all the possible arrangements of defects in this highly frustrated environment (Čopar et al, Soft Matter 9, 2013).

Further pair interactions between colloidal particles in confined cholesteric cells have been measured. The interaction profile contains energy minima and thus allows metastable states, the number of which increases with chirality. A description for this phenomenon has been postulated

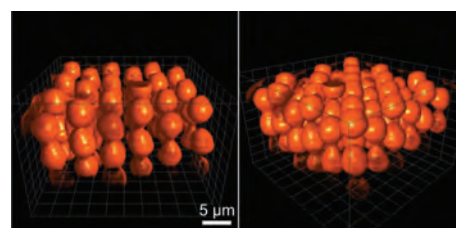


Figure 10: 3D image of a nematic colloidal crystal, reconstructed from fluorescent confocal imaging.

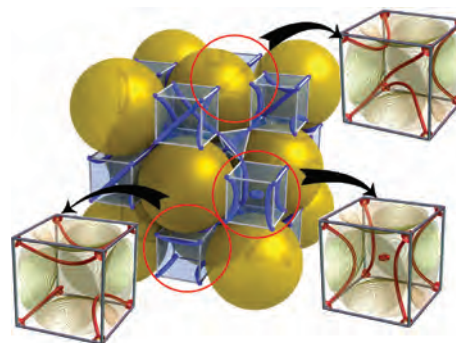


Figure 11: Modelling of the disclination network in nematic permeating opal structure.

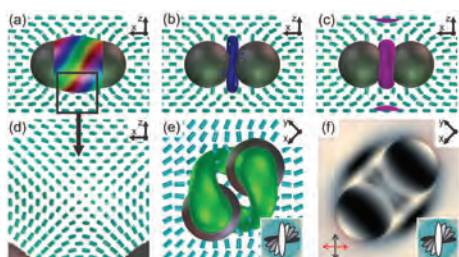


Figure 12: Colloidal pair in an unwound chiral nematic in a bubble-gum structure. a-e visualization of the director fields and ordering tensor derivatives. f simulated polarization microscopy

and probed with computer simulations (Jampani et al, PRL 110, 2013). Related studies of colloidal systems with morphologically and topologically different parameters, performed in collaboration with foreign groups, yielded publications in co-authorship (Gharbi et al, Soft Matter 9, 2013; Geng et al, Soft Matter 9, 2013; Cavallaro et al, Soft Matter 9, 2013; Cavallaro et al, PNAS 110, 2013).

Visualization of nematic defects

Analysis of the data produced by numerical simulations and advanced experimental methods requires a host of visualization methods to highlight the parameters of interest (Figure 12). An expansive review over the most common methods has been published, together with examples based on well-known models (Čopar, Porenta, Žumer, Liq. Cryst. 2013).

Nanoparticles dispersed in mesophases

We have demonstrated experimentally and theoretically that the interaction between nanoparticles and topological defects induces a twist-grain boundary phase in a chiral liquid crystal. The occurrence of this phase, the analogue of the Shubnikov phase in type-II superconductors, is driven by the direct interaction between surface-functionalized CdSe quantum dots and screw dislocations. It is shown that, within a universal adaptive-defect-core-targeting mechanism, nanoparticles of the appropriate size and functionalization adapt to qualitatively different cores of topological defects such as disclination lines and screw dislocations. The findings suggest new pathways towards the controlled assembly of superstructures in diverse, symmetry-broken, condensed-matter systems, ranging from nanoparticle-decorated liquid crystals to superconductors (G. Cordoyannis et al., Soft matter 9, 3956 (2013)). Furthermore, we have studied the impact of surface-functionalized graphene nanosheets on the blue-phase range of a chiral liquid crystal. Calorimetric and optical measurements demonstrate that the resulting soft nanocomposite exhibits an increased blue phase temperature stability range for a minute concentration of dispersed graphene. The impact is stronger on the more ordered, cubic structured blue phase I. Experimental results were discussed in the frame of Landau-de Gennes mesoscopic model in terms of the tensor order parameter. These findings suggest that anisotropic nanoparticles may be of great usefulness for stabilizing the blue phases (M. Lavrič et al., Appl. Phys. Lett. 103, 143116 (2013)).

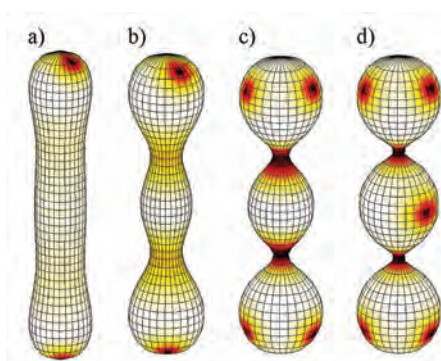


Figure 13: Impact of curvature on the number and position of topological defects.

Membrane budding and formation and release of microvesicles

The latter might play an important role in long distance cell-cell communication owing to their ability to move with body fluids. Several mechanisms exist that might trigger pinching off of globular buds from the parent membrane (vesiculation). We have considered theoretically the impact of topological defects (TDs) on this process in the membranes exhibiting global in-plane orientational order. Landau-de Gennes type theoretical approach is used in terms of the tensor orientational order parameter. We show on membrane structures exhibiting spherical topology that the coexistence of regions with positive and negative Gaussian curvature might trigger pairs *defect-antidefect* for strong enough local membrane curvatures. Critical conditions for this event are determined for several demonstrative cases (Figure 13). We claim that concentration of TDs at narrow necks might trigger membrane fission neck rupture, enabling a membrane fission process and the release of membrane daughter microvesicles (D. Jesenek et al., International journal of nanomedicine 8, 677 (2013)).

Photonic properties of smectic fibres

In 2013, a lot of attention was paid to our studies of the photonic properties of liquid crystal dispersions. We have studied the resonant transport of light between a planar polymer waveguide and a nematic droplet-optical microresonator in close proximity to the waveguide. White light from a supercontinuum laser that was guided along the planar waveguide, it was seen to be resonantly transferred via photon tunnelling into the Whispering Gallery Modes of the microresonators. A theoretical analysis was also performed within the coupled-mode approach, the article was published in Jampani et al. Optics Express 2013. In the same journal we published in December 2013 in cooperation with partners from Max Planck Institute, Goettingen, an article on the lasing and waveguiding in smectic-A optical fibres (Peddireddy et al, Optics Express 2013). We observed that in contact with water and CTAB, a smectic liquid crystal spontaneously forms micrometre-diameter fibres. Using confocal microscopy, we reconstructed the layered structure of these fibres. The smectic layers are wrapped-up into a series of closed and concentric molecular layers, forming a +1 topological defect in the core of the fibre. These fibres are excellent waveguides and it is possible to induce laser emission from fibres doped with fluorescent molecules (Figure 14). The article has attracted



Figure 14: Smectic-A liquid crystal spontaneously forms optical fibres that are excellent waveguides and laser emitters.

considerable attention, because it was selected by the editors of all the Optical Society of America journals as the highlight article of December 2013. We have also published a review article on the photonics and topology of nematic colloids and dispersions (I. Muševič, *Phil. Trans. Royal Soc. A* 2013).

Molecular motors

We developed a model for the dynamics of cytoplasmic dynein, which is one of the largest and most complex motor proteins. We used an elastomechanical model for each individual dynein head and combined it with a minimal model of the chemical cycle of ATP hydrolysis. We showed that a dimeric molecule, consisting of two heads, can synchronize their cycles and step with regular 8-nm steps if the coupling is sufficiently strong (Figure 15). This is the stepping pattern observed in mammalian dynein. With weaker coupling the heads lose synchrony and move with a much broader distribution of step sizes, but it is still capable of pulling a load. The mode of stepping then corresponds to that observed in yeast dyneins. This shows that the walking mechanism of dynein is robust in itself, but its efficiency and processivity are improved significantly by the coupling between the heads (*A. Šarlah and A. Vilfan, The winch model can explain both coordinated and uncoordinated stepping of cytoplasmic dynein; submitted*).

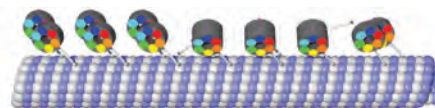


Figure 15: Stepping of a model cytoplasmic dynein molecule.

LC applications

The Jožef Stefan Institute (JSI) and its spin-off Company, Balder Ltd that was acquired by the multinational Kimberly Clark Corporation (KC) in 2012 were in the past years intensively developing the new concept of LC optical light shutters based on optically compensated birefringence in Super-twisted LCDs. The innovative technical solutions were upgraded (24.9.2013) with a Continuation-in-part Patent US 8,542,334. The new LC light shutter technology is finally protected by 6 granted international patents (USA and EU). The above technology based on the proprietary IP allows Balder (KC) to become the only producer of the LC welding filters in the world that can label its products with the prestigious CE 1/1/1/1 quality certificate. On the grounds of the high performance of Balder's (KC) products, the International Standard Organization invited JSI to participate in the ISO expert group ISO/TC94/SC6/WG2 and WG4 preparing new ISO standard on Eye Protection. The new LC light-shutter technology was recently (2013) upgraded by the emerging spatial light filtering technique (Figure 16). It allows the extension of the application of the LCD optical filters into the field of light hazard (e.g., glare) eye protection against collimated light sources (e.g. car headlights).

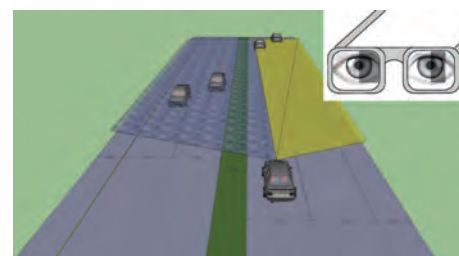


Figure 16: Spatial light filtering glass.

Low-friction nanomaterials

In the paper entitled "Nanoparticles as novel lubricating additives in a green, physically based lubrication technology for DLC coatings", M. Kalin, J. Kogovšek, and M. Remskar, *Wear* 303, 480 (2013), we report on a significant improvement of the friction behaviour of diamond-like carbon (DLC) tribological contacts by addition of MoS₂ nanotubes into PAO oil in 2 wt.%. The friction coefficient measured in the most severe conditions was reduced by up to 50%, compared to using only base PAO oil. In the paper "Influence of surface roughness and running-in on the lubrication of steel surfaces with oil containing MoS₂ nanotubes in all lubrication regimes", by J. Kogovšek, M. Remskar, A. Mrzel, and M. Kalin, *Tribology International* 61, 40 (2013), we reported that the friction at the steel contact drops by 40–65% when 2 wt.% of MoS₂ nanotubes are added to base oil. Furthermore, using MoS₂ nanotubes, the friction is the same for rough and smooth steel surfaces, which indicates a reduced need for fine surface finishing when surfaces are lubricated by MoS₂ nanotubes.

Nanoelectronics

In the paper "Comparative study of chemically synthesized and exfoliated multilayer MoS₂ field-effect transistors", HS Hwang, M. Remskar, et al., *Applied Physics Letters*, 102, 043116-1 (2013), we report on field-effect transistor (FET) device based on as-synthesized MoS₂ nanoflakes in comparison to thin flakes prepared by exfoliation of bulk MoS₂. The transistor characteristics were found to be almost identical; the on/off current ratio is 10⁵ and transistor behaviour of n-type.

Polymer nanocomposites

In the paper "A novel structure of polyvinylidene fluoride (PVDF) stabilized by MoS₂ nanotubes", M. Remskar, et al., *Soft Matter* 9, 8647 (2013) we report on the first polyvinylidene fluoride (PVDF)-MoS₂ nanotube based nanocomposites. The results indicate that the polymer-nanotube interaction stabilizes a novel 2b stacking within the γ -phase, which represents a new PVDF crystal structure. Annealing of the PVDF-MoS₂ nanotube films leads to a completely relaxed α -phase with the nanotubes forming the nucleation centres for crystallization of the dendritic phase. Tribological properties of these films, which evidence that 1 wt.% of MoS₂ nanotubes in PVDF reduces fric-

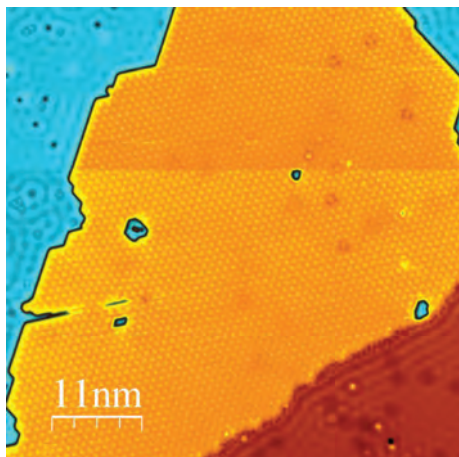


Figure 17: High-resolution STM image of a Pb monolayer on a Cu(111) surface, showing a Moire pattern. (size 50 x 50 nm², It=91 mV, Ut=0.8 nA, T=4.2K).

tion by more than 20% with regard to pure PVDF, while 2 wt.% by more than 70%, were published in the paper "Friction properties of polyvinylidene fluoride with added MoS₂ nanotubes", M. Remškar et al., *Physica Status Solidi. A, Applications and Materials Science*, 210, 2314 (2013). Raman spectroscopy revealed that sliding in the boundary lubrication regime can trigger the phase transformation to polar PVDF phase in similar way as the drawing during crystallization.

Nanosafety

We prepared a leaflet entitled "Fireworks and other pyrotechnics for entertainment poison air" with the goal to raise awareness of hazardous air pollution by nanoparticles released during fireworks and the combustion of sparklers. The leaflet is available at the public link http://www.uk.gov.si/fileadmin/uk.gov.si/pageuploads/pdf/Ognjemeti_dokoncna.pdf,

Nanoscale superconductivity

Confined metal nanostructures, such as monolayers or small islands of different thicknesses, are very interesting for probing the ultimate limits of nanoscale superconductivity. We are studying the relationship between bulk and nanostructure superconductive critical temperatures (T_c). In particular, we are trying to control T_c on a nanoscale. High-quality Pb ultra-thin films (from one to few monolayers thick) have been deposited in ultra-high vacuum on an atomically flat Cu (111) surface. For low coverage a monoatomic hexagonal close-packed Pb film is formed, which shows an inverse corrugation (Figure). For higher coverage, a Stranski-Krastanov growth of 3D Pb islands is observed, several monolayers thick. Low-temperature STM and STS measurements were performed down to 1K on such surfaces to study their atomic and electronic structures.

Charge density wave compounds

The real crystal structure of the (NbSe₄)(10/3)I charge density wave (CDW) compound was studied by simulation of the X-ray diffuse scattering. The average structure of the low-temperature twinned phase was determined and the phase transition was attributed to the formation of a CDW. In addition to the experiments, the electronic properties of the high- and the low-temperature phases were calculated with the extended Hückel tight-binding method. The Fermi surfaces of the average structures above and below the phase transition appear very similar and their shapes support a nesting instability and a CDW formation.

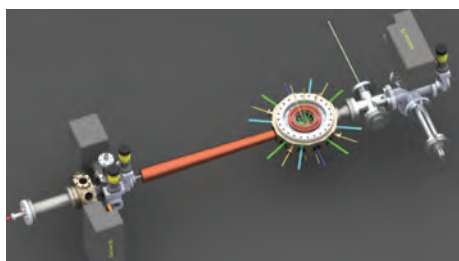


Figure 18: Schematic representation of an UHV system, built and tested for experiments with ultra-cold Cs atoms.

Ultra-cold atoms

An in-house-built ultra-high vacuum apparatus was constructed and tested for experiments on strongly correlated systems with Cs atoms (Figure). Next, different laser systems are being set up, which will in combination with magnetic fields be used to slow down, capture, compress and cool down atoms to nK temperatures.

III. Research programme "Experimental Biophysics of Complex Systems"

Within the program "Experimental Biophysics of Complex Systems" we explore processes and structures of various complex systems (from model systems to the structures in living cells, tissues and even small animals) including the effects of various bioactive molecules like toxins, drugs, etc., as well as of various materials like nanomaterials and medical materials on these systems. Our research is focused on the investigation of structural properties of different membrane structures such as membrane domains, membrane proteins and glycosaccharide matrix as well as their interactions with various materials that enter into their native environment. Novel spectroscopic and

By the analysis of the polarization dependence of fluorescence, we revealed that some widely used membrane probes undertake several lipid phase-dependent conformations at distances below optical spatial resolution. Based on detailed optical microscopy measurements of the dissolution of blood clots model in an artificial perfusion system, we have developed a mathematical model describing the thrombolysis as a corrosion-erosion process.

microspectroscopic techniques contribute to the understanding of the organization of these supramolecular systems, complex cell and tissue responses as well as opening new possibilities to design new medical materials, like scaffolds for tissue regeneration as one of the most relevant problems in the current aging population of the developed countries. In addition, we focus on medical method optimization, like tumour treatment methods, magnetic resonance imaging and the mathematical modelling of trombolysis, magnetic resonance microscopy in forestry, wood science and food processing as well as to restricted diffusion research.

One of the hottest topics of current biophysics is certainly the study of the interactions between novel materials and cells, especially from the

bioactivity and biocompatibility point of view, which we explore by applying novel microspectroscopies. The basic question is: do nanoparticles and nanofibres enter cell membranes. The partitioning of the nanoparticles was studied via FMS-FRET experiments on model membranes, exposed to the diffusing nanoparticles on a micron scale. The nanoparticles first accumulated on membranes coming into the molecular neighbourhood of the membrane probes, which enhanced the membrane probe signal due to FRET. After approximately 40 min. the liposomes start to degrade and the membrane signal was detected everywhere within the micrometre neighbourhood.

Our system for fluorescence microspectroscopy enables us to acquire fluorescence spectra from microscopic volume elements of the sample and thus to detect physical changes in local molecular environment of fluorescent probes. By stochastic wavelength sampling and efficient computer simulations we improved spectral resolution and bleaching correction reliability, as we reported in the published article "Bleaching-corrected fluorescence microspectroscopy with nanometer peak position resolution. *Opt. Express* vol. 21, no. 21, p. 25291-25306". Upgrading the analysis by polarization dependence of emitted fluorescence, we revealed that some widely used membrane probes undertake several lipid phase-dependent conformations at distances below optical spatial resolution. We published our findings in the article "Coexistence of probe conformations in lipid phases: a polarized fluorescence microspectroscopy study. *Biophys. J.*, vol. 105, no. 4, p. 919-927". As a part of our cell-nanomaterial interaction research, we used resonance energy transfer imaging to investigate rates and mechanisms of titanate nanoparticles' penetration through membranes of giant vesicles. The system for optical micromanipulation was used to study the dynamics and strength of cell attachment to macrostructured biomedical materials that are used as models for potential artificial tissue scaffolds. The results were correlated by molecular (EPR) and macroscopic (morphology, rheology, viscoelasticity) properties of the scaffolds.

In the area of the design and synthesis of probes (nitroxide, fluorophore and combination of both in the same molecule) in 2013 focus was on the synthesis of environment sensitive fluorescent probes (sensitive to polarity and hydration of the environment). A small series of fluorophores was synthesized by linking of 7-(diethylamino) coumarin and different aromatic systems with oxazole. Synthesized dyes display red shift of absorption as well as emission spectra. Fluorescence emission spectra in solvents of increasing polarity exhibit decrease of fluorescence intensity and red shift of emission maxima. Under our experimental conditions synthesized fluorophores display excellent photostability compared to NBD type probes. 7-(diethylamino)coumarin represented also the basis of for a small series of double spin-fluorescent probes. The influence of distance between fluorophore and nitroxide was examined with these probes. Several pH dependant probes of rhodamine type were also evaluated in regard to their photophysical properties.

In collaboration with Biotechnical faculty we have investigated how structural properties of several phenolic substances influence their binding and interaction with liposome membranes. Phenolics are antioxidants with antimicrobial effect and are therefore interesting as bio-additives for food industry. Results obtained using EPR, fluorescence anisotropy and differential scanning calorimetry show that phenolics investigated decrease membrane fluidity and are bounded to a membrane surface predominately via hydrogen bonds (*Food chemistry*, 2013,139:804-813).

In collaboration with Hacettepe University, from Ankara, Turkey, the influence of tricyclic antidepressant clomipramine (CLO) on model and biological stratum corneum (SC) membrane was investigated by EPR. The fluidizing effect of CLO on pig ear SC throughout the whole membrane indicates that CLO penetrates into the stratum corneum, which is important for its transdermal delivery (*J. Pharm. Sci.* 2013, DOI 10.1002/jps.23687).

In collaboration with Max Delbrück Center for Molecular medicine in Berlin, Germany, we have investigated the role of lysophospholipid, perifosine (OPP) as a constituent of liposome membrane on trans-cell barrier transport of liposome encapsulated drugs. We have shown that liposome membrane fluidity decreases with increasing concentration of perifosine in liposomes. This could be a reason for the increased release of the liposome encapsulated hydrophilic substance measured with the increasing concentration of perifosine. Our results indicate that the efficient transport of liposome-encapsulated hydrophilic drugs across the barrier into a disease-affected tissue is possible with liposomal formulations, which contain sufficient amounts of perifosine to open the channels in the barrier and release the liposome content when the cell barrier is compromised. This opens a new possibility of using lysolipid-containing liposomal formulations as drug delivery systems (submitted for publication).

We have recently shown that the structure of water confined between lipid membranes is perturbed with respect to bulk water. Due to a low light penetration depth the attenuated total reflection Fourier transform infrared (ATR-FTIR) spectroscopy is specifically suited to study interlamellar water structure in multibilayers. Sequential modification of interlamellar water perturbation can be followed with a step-by-step dehydration of samples either by water evaporation or by osmotic pressure. Besides different levels of hydration, the lipid-water interaction can be studied for lipids with different headgroups and for different lipid phases. Modification of interlamellar water properties could explain water-mediated effects on biological processes. This can have implications to membranes adhesion, stacking, and fusion.

Using molecular dynamics (MD) we calculated partition coefficients between the membrane and water phase for several commonly used labels (two spin labels and a fluorescent marker). Coefficients were obtained by first calculating the free energy for the transition from the membrane into water using adaptive biasing force (ABF) MD. The results allow us to perform experiments with greater precision and more economically. Part of the results is summarized in the graduation work of Klara Presecnik with the title "Determination of partitioning coefficients of amphiphilic molecules between membrane and water using molecular dynamics (ABF)". We have created a generally applicable software package for determining position-dependent diffusion coefficients (available at github.com/lbf-ijs/DiffusiveDynamics). The package is capable of obtaining and visualizing diffusion for one- and two-dimensional cases. With the obtained diffusion surface and a known free energy surface, diffusive trajectories can be generated. Thereby the time reach of molecular dynamics, typically a few 100 nanoseconds, can be extended to several 100 microseconds (for the 1D or 2D subspace of interest). The method for determining the diffusion is most efficiently used with ABF MD. With this methodology, the motion of spin labels in the membrane can be studied, thus further improving the empirical approximation used by side-chain conformational space modelling of proteins (CSM). Such estimates allow us to significantly reduce the computational time needed for determining the size of the side-chain conformational space. This also enables us to solve inverse problems - for example, the structural characterization of membrane proteins.

We started experimental work on cysteine mutants of the N-terminal part of the antimicrobial peptide β -defensin. The ultimate purpose of the experiments is to determine the 3D structure of peptides in various environments using CSM. Using circular dichroism (CD) and the EPR we observed two different conformations we have already observed two conformations. We also discovered conditions under which the transition between conformations can be controlled by varying the pH.

The use of one-dimensional nanoparticles, such as TiO₂ nanotubes, offers a promising low-cost and effective alternative to current disinfection methods used in food processing industry and in hospital environment. In order to improve antibacterial properties of surfaces we developed a stable deposition of TiO₂ nanotubes on polyethylene terephthalate (PET) surface, a material commonly used in food processing industry and hospital environment. PET surfaces with this kind of antibacterial nanocoating (ABnC) retard growth of bacteria by up to one order of magnitude when illuminated by ordinary fluorescent light bulbs.

Thrombolysis is the process in which the addition of specific agents (thrombolytic agents) in the bloodstream can dissolve the blood clots. The usual way that a thrombolytic agent functions is that it initially activates a molecule of plasminogen to its active form plasmin and this in turn degrades the fibrin network of which the clot is made. In a large study, which was started two years ago, we studied the possibility of using a direct thrombolytic agent in which the conversion of plasminogen to plasmin would no longer be needed. Namely, in the bloodstream was directly added plasmin. Its effect on thrombolysis was then followed by an optical microscope, by which we monitored the progress of degradation of artificial blood clots in contact with plasmin molecules. The process of blood clot dissolving was also recorded with a digital camera and images were then analysed so that we could analyse the dynamics of blood clot dissolution. The obtained results were then analysed by an appropriate mathematical model of blood clot dissolution. The findings of this study were published in the journal *Blood coagulation and fibrinolysis*, another article with similar content is in the publishing process in the *Thrombosis Research*.

The magnetic resonance imaging (MRI) can also enable monitoring of the development of caries of the teeth and dental tissue impairment caused by caries. However, MRI has of course a number of limitations. The first is that MRI of teeth is currently too demanding that it could be performed *in vivo* successfully. Therefore, our study had to be performed on extracted teeth. Another limitation is that MRI is not capable of imaging of hard dental tissues such as enamel and dentin, at least not in its standard way. However, we still come up with interesting findings with regard to caries. Namely, one of the effects of caries is also dentin demineralization. Due to the demineralization carious dentin produces much more signal than intact dentin, so that regions of demineralized dentin can be easily detected with T1-weighted imaging. Another interesting finding is that caries also affects dental pulp tissue. The changes can be clearly seen in maps of relaxation time T₂, as well as in maps of apparent diffusion constants (ADC). The findings of the study were recently published in the *Caries Research*.

Magnetic resonance imaging allows monitoring of the distribution of electric current density in the conductive samples. By using current images in several different arrangements of electrodes, it is possible to determine the electrical conductivity of the sample and consequently also the electric field for a given electrode arrangement. This is of paramount importance in electroporation, which is a method in which by the use of high voltage cell membrane is a tissue are made temporary permeable and therefore absorb more drugs than normally, as for example anti-cancer drugs. In this area in the past year, we worked with a group of prof. Damian Miklavčič from the Faculty of Electrical Engineering. Within this collaboration, we conducted a number of important *in vivo* MRI experiments of current distribution during electroporation last year. Until last year these experiments were successfully done only on model samples, but not on experimental animals. Experiments on animals have greater importance because

they can be used for determination of the presence and extent of the region of reversible electroporation. In this region, the tissue cells open for a short time and in this time an anticancer drug can enter the cells, after that the cells close again. Cancer cells in this process die while most of healthy cells should survive. In our experiments, instead of the anticancer drug a MRI contrast agent was injected into experimental animals. In the region of reversible electroporation is the contrast agent remained in the tissue also after several days while it was not present at that time in other tissues that were not reversibly electroporated. Thus, we were able to detect the region of reversible electroporation and also to compare its extent with predations for the region that were done based on calculations of electric field strength on the basis of the measured current density distribution. The findings of this study were sent to the journal Radiology.

Controlled drug-delivery systems are widely used in pharmaceutical industry because of their numerous advantages. For hydrophilic polymers, it is generally accepted that, once in contact with body fluids, they hydrate and swell, forming a gel layer that regulates the penetration of body fluids into the tablet and the dissolution of the incorporated drug. Therefore the knowledge of the gel layer characteristics is of a crucial importance for the use of controlled drug delivery systems. Combination of different MRI methods enables accurate determination of medium penetration into the tablet as well as hydrogel formation *in situ*. MR imaging was used to study the impact of a soluble active substance in the dynamics of the penetration of the medium into the tablet and the formation of the gel layer. Acquired knowledge in this area was found interesting for our pharmaceutical company Krka, for which numerous studies were conducted within the last year.

The method of application of the gradient pulses in combination with the spin-echo (PGSE method) enables measurement of the translational motion. In this method there several free parameters of the PGSE sequence, which may affect how sensitive this method is for detection of the diffusion spectrum. The same method can be adjusted for measurement of the fast motion on a short time scale as well as of the slow motion on the longer time scale, depending on the parameters of the method. These features of the PGSE method were confirmed by measurements on molten polyethylene. The results confirm a model of constraint release in a system of entangled polymer chains as a sort of tube Rouse motion. The results of this research were published in the Journal of Magnetic Resonance.

Our research has been supported by a number of international projects financed by the European Union within the 6th and 7th Frameworks. It was also supported within the bilateral Slovenian – USA, Slovenian – German and Slovenian – Greek and other scientific cooperations. In 2013, the Department had cooperations with 108 partners from Slovenia and abroad. Among them:

- The high magnetic field centers in Grenoble, France, and Nijmegen, The Netherlands
- The high magnetic field center at the University Florida, Tallahassee, Florida, USA
- The ETH, Zürich, Switzerland
- The Ioffe Institute in St. Petersburg, Russia
- The University of Duisburg, the University of Mainz and the University of Saarbrücken in Germany
- The University of California, the University of Utah and the Liquid Crystal Institute, Kent, Ohio, USA,
- National Institute for Research in Inorganic Materials, Tsukuba, Japan
- NCSR Demokritos, Greece
- Institut für Biophysik und Nanosystemforschung OAW, Graz, Austria
- Bioénergétique et Ingénierie des Protéines, CNRS Marseille, France
- Architecture et Fonction des Macromolécules Biologiques, CNRS Marseille, France
- The Max Delbrück Center for Molecular medicine in Berlin
- The Dartmouth Medical School, Hanover, NH, USA
- The Mayo Clinic, Rochester, USA

made the above studies possible.

Some outstanding publications in the past year

1. Vallejos, S., Umek, P., Stoycheva, T., Annanouch, F., Llobert, E., Correig, X., de Marco, P., Bittencourt, C., Blackman, C.: Single-step deposition of Au- and Pt-nanoparticle-functionalized tungsten oxide nanoneedles synthesized via aerosol-assisted CVD, and used for fabrication of selective gas microsensor arrays. *Advanced Functional Materials* 23, 1313–1322 (2013)
2. Gradišek, A., Bomholdtravnbaek, D., Vrtnik, S., Kocjan, A., Lužnik, J., Apih, T., Jensen, T., Skripov, A. V., Dolinšek, J.: NMR study of molecular dynamics in complex metal borohydride LiZn_2BH_4 . *Journal Phys. Chem. C* 117, 21139–21147 (2013)

3. Pregelj, M., Zorko, A., Zaharko, O., Jeglič, P., Kutnjak, Z., Jagličič, Z., Jazbec, S., Luetkens, H., Hillier, A. D., Berger, H., Arčon, D.: Multiferroicity in the geometrically frustrated $\text{FeTe}_2\text{O}_5\text{Cl}$. *Phys. Rev. B* **88**, 224421-1-10 (2013)
4. Nych, A., Ognysta, U., Škarabot, M., Ravnik, M., Žumer, S., Muševič, I.: Assembly and control of 3D nematic dipolar colloidal crystals. *Nature Communications* **4**, 1489-1-8 (2013), doi: 10.1038/ncomms 2486.2013
5. Jampani, V. S. R., Škarabot, M., Čopar, S., Žumer, S., Muševič, I.: Chirality screening and metastable states in chiral nematic colloids. *Phys. Rev. Lett.* **110**, 177801-1-5 (2013)
6. Novak, S., Drobne, D., Vaccari, L., Kiskinova, M. P., Ferraris, P., Birarda, G., Remškar, M., Hočevar, M.: Effect of ingested tungsten oxide (WO_x) nanofibers on digestive gland tissue of Porcellio scaber (Isopoda, Crustacea): fourier transform infrared (FTIR) imaging. *Env. Sci. & Tech.* **47**, 11284-11292 (2013)
7. Bajd, F., Serša, I.: Mathematical modeling of blood clot fragmentation during flow-mediated thrombolysis. *Bioph. Journal* **104**, 1181-1190(2013).
8. Urbančič, I., Ljubetič, A., Arsov, Z., Štrancar, J.: Coexistence of probe conformations in lipid phases: a polarized fluorescence microspectroscopy study. *Bioph. Journal* **105**, 919-927 (2013)

Some outstanding publications in 2012

1. Guttman, P., Rembein, S., Bittencourt, C., Umek, P., Ke, Xi., van Tandeloo, G., Ewels, C. P., Schneider, G.: Nanoscale spectroscopy with polarized X-rays by NEXAFS-TXM. *Nature Photonics* **6**, 25-29 (2012)
2. Dolinšek, J.: Electrical and thermal transport properties of icosahedral and decagonal quasicrystals. *Chem. Soc. Rev.* **41**, 6730-6744 (2012)
3. Pregelj, M., Zorko, A., Zaharko, O., Arčon, D., Komelj, M., Hillier, A. D., Berger, H.: Persistent spin dynamics Intrinsic to amplitude-modulated long-range magnetic order. *Phys. Rev. Lett.* **109**, 227202-1-5 (2012)
4. Novak, N., Pirc, R., Wencka, M., Kunjak, Z.: High-resolution calorimetric study of $\text{Pb Mg}_{1/3} \text{Nb}_{2/3} \text{O}_3$ single crystal. *Phys. Rev. Lett.* **109**, 037601-1-5 (2012)
5. Zupančič, B., Diez-Berart, S., Finotello, D., Lavrentovich, O. D., Zalar, B.: Photoisomerization-controlled phase segregation in a submicron confined azonematic liquid crystal. *Phys. Rev. Lett.* **108**, 257801-1-5 (2012)
6. Vilfan, A.: Optimal shapes of surface slip driven self-propelled microswimmers. *Phys. Rev. Lett.* **109**, 128105-1-5 (2012)
7. Hwang, W. S., Remškar, M.: Transistors with chemically synthesized layered semiconductor WS_2 exhibiting 10^5 room temperature modulation and ambipolar behavior. *Appl. Phys. Lett.* **101**, 013107-1-4 (2012)
8. Essone Mezeme, M., Kranjc, M., Bajd, F., Serša, I., Brosseau, C., Miklavčič, D.: Assessing how electroporation affects the effective conductivity tensor of biological tissues. *Appl. Phys. Lett.* **101**, 1-4 (2012)
9. Bajd, F., Vidmar, J., Fabjan, A., Blinc, A., Kralj, E., Bizjak, N., Serša, I.: Impact of altered venous hemodynamic conditions on the formation of platelet layers in thromboemboli. *Thromb. Res.* **129**, 158-163 (2012)

Awards and appointments

1. Matjaž Gomilšek: Prešeren Award of the Faculty of Mathematics and Physics for Diploma thesis, University of Ljubljana, Ljubljana, Time irreversible billiards
2. Primož Koželj: Best paper award, Ljubljana, The European Integrated Center for the Development of New Metallic Alloys and Compounds, C-MAC days 2013, Ljubljana
3. Zdravko Kutnjak: Mentor awards in 2013, the Society of Young Researchers Slovenia

Organization of conferences, congresses and meetings

1. "C-MAC days 2013", Ljubljana, Slovenia, 9.-12. 12. 2013

Patent granted

1. Janez Pirš, Matej Bažec, Silvija Pirš, Bojan Marin, Bernarda Urankar, Dušan Ponikvar, Variable contrast, wide viewing angle LCD light-switching filter, US8542334 (B2), US Patent Office, 24.9.2013.
2. S. G. Psakhie, Volia Isaevich Itin, D. A. Magajeva, O. G. Terehova, E. P. Najden, Olga Vasiljeva, Georgij Mihajlov Andrejevič, Urška Mikac, Boris Turk, Contrast agent for T1 and/or T2 magnetic resonant scanning and method for preparing it, RU2471502 (C1), Federal'naja služba po intelektual'noj so'stvennosti, 10.1.2013.
3. Maja Remškar, Marko Viršek, Miha Kocmur, Adolf Jesih, Procedure for synthesis of threadlike tungsten oxide W_5O_{14} , US8496907 (B2), US Patent Office, 30.7.2013.

INTERNATIONAL PROJECTS

- MERCK - AFM Investigations
Merck KGaA
Asst. Prof. Miha Škarabot
- 7FP - DIAGNO-RAIL; Combining Innovative Portable Visual, Acoustic, Magnetic and NMR Methods with In-situ Chemical Diagnostic Tools for Effective Failure Assessment and Maintenance Strategy of Rail and Subway Systems
European Commission
Prof. Janez Dolinšek
- 7FP - LEMSUPER; Light Element Molecular Superconductivity: An Interdisciplinary Approach
European Commission
Prof. Denis Arčon
- 7FP - ESNSTM; Electron Spin Noise Scanning Tunneling Microscopy
European Commission
Prof. Janez Dolinšek
- 7FP - NanoMag; Magnetic Nanoparticles and Thin Films for Spintronic Applications and High Performance Permanent Magnets
European Commission
Prof. Janez Dolinšek
- 7FP - NEMCODE; Controlled Assembly and Stabilisation of Functionalised Colloids in Nematic Liquid Crystals
European Commission
Prof. Igor Muševič
- COST MP1003; ESNAM - European Scientific Network for Artificial Muscles
COST Office
Prof. Boštjan Zalar
- COST; IMC-SRM; Network for Intermetallic Compounds as Catalysts for Steam Reforming of Methanol
COST Office
Prof. Janez Dolinšek
- NATO ARW 984375; Magnetic Resonance Detection of Explosives and Illicit Materials, 2.-7.9.12, Turkey
NATO - North Atlantic Treaty Organisation
Asst. Prof. Tomaž Apih
- COST MP1201; Rational Design of Hybrid Organic-Inorganic Interfaces: The Next Step Towards Advanced Functional Materials
COST Office
Dr. Polona Umek
- Factor Xa Dimerization and Its Role in Prothrombinase Complex Formation and Activity on Membrane Surfaces
Slovenian Research Agency
Dr. Marjeta Šentjurc
- Synthesis, Microscopy Characterization and Magneto Resonance Study of New Functional Nanomaterials
Slovenian Research Agency
Dr. Polona Umek
- Unconventional Ground States of Quantum Matter
Slovenian Research Agency
Dr. Martin Klanjšek
- Exotic Electronic Properties arising from Geometrical Symmetry
Slovenian Research Agency
Prof. Denis Arčon
- Physiological Role of Factor Xa and Protein S in Coagulation and Inflammation
Slovenian Research Agency
Dr. Tilen Koklič
- Novel Polymeric and Ionomeric Materials with Giant Dielectric and Electrocaloric Response
Slovenian Research Agency
Asst. Prof. Vid Bobnar
- Liquid Crystals Blue Phases in Confined Geometries: Structure, Optical Properties and Photonic Applications
Slovenian Research Agency
Prof. Igor Muševič
- Elastically Tuned Soft Nanocomposites
Slovenian Research Agency
Prof. Samo Kralj
- Promotion of Science and Cooperation of International Scientific Associations
European Commission
Prof. Igor Muševič

RESEARCH PROGRAMS

- Magnetic Resonance and Dielectric Spectroscopy of „Smart“ New Materials
Prof. Janez Dolinšek

- Physics of Soft Matter, Surfaces and Nanostructures
Prof. Slobodan Žumer
- Experimental Biophysics of Complex Systems
Prof. Igor Serša

R&D GRANTS AND CONTRACTS

- New Metallic Materials for Thermal Storage of Digital Information
Prof. Janez Dolinšek
- Design, Formulation and Characterization of Biomimetic Nanocomposite Systems for Effective Tissue Regeneration
Dr. Mojca Urška Mikac
- Theory of the Nematic Nanodroplet and Ordering of DNA, Encapsidated in Simple viruses
Asst. Prof. Andrej Vilfan
- Collective and Molecular Dynamics of Photosensitive Liquid Crystal Elastomers
Prof. Boštjan Zalar
- Use of Green Energy Sources: New Functional Nanomaterials on the Base of Polyoxometalates and TiO₂ Nanostructures for Production of Hydrogen by Catalytic Oxidation of Water -NANOleaf
Dr. Polona Umek
- Oligomers of Amyloidogenic Proteins from A to Z: Biophysical Properties, Structure, Function and Mutual Interactions
Asst. Prof. Miha Škarabot
- Optimization Strategies in Biological and Artificial Microfluidic Systems
Asst. Prof. Andrej Vilfan
- Selective and Hipsensitive Microcapacitive Sensor System for Targetted Molecular Detection in the Atmosphere
Prof. Igor Muševič
- Textured Ceramic Layers for Sensors and Actuators
prof. dr. Zdravko Kutnjak
- Optical Microresonators Based on Liquid Crystals
Prof. Igor Muševič
- Biotechnological Processes of Treatment of Lignocellulosic Materials
Prof. Janez Štrancar
- Behaviour of Dissipative Systems Under Extreme Thermo-Mechanical Loading
Dr. Andrej Zorko
- Water Exclusion Efficacy, Measure for Prediction of Wood Performance against Wood Decay Fungi
Prof. Igor Serša
- New Materials for Power Conversion: Oxide Semiconductor Thermoelectrics
Prof. Boštjan Zalar
- A Spectrometer for Automatic ¹⁴N Nuclear Quadrupole Resonance Characterization of New Substances
Dr. Alan Gregorovič
- Exchange Interactions in Selenides and Tellurides – Key for New Functional Low-Dimensional Magnetic Systems
Dr. Matej Pregelj
- TABANA: Targeting Antimicrobial Activity via micro/Nano-structured surfaces for civil Applications
Prof. Janez Štrancar
- Nanomaterials and Scaffolds Preparation and Characterization
Prof. Janez Štrancar
- New Polymer and Ceramic Materials for Potential Use in Capacitors
Dr. Andreja Eršte
- Influence of Mechanical Field on Electrical Properties of Oxide Semiconductor Materials
Dr. Nikola Novak
- Irradiation and Analysis of Si Samples
Prof. Igor Muševič

NEW CONTRACTS

- Protocol for Validation of the Analytical Method
Lek d. d.
Asst. Prof. Miha Škarabot
- A Spectrometer for Automatic ¹⁴N Nuclear Quadrupole Resonance Characterization of New Substances
Gorenje Gospodinjski Aparati d.d.
Dr. Alan Gregorovič
- Balder - Technology Development
BALDER d.o.o.
Prof. Igor Muševič
- Behaviour of Dissipative Systems under Extreme Thermo-Mechanical Loading
BALDER d.o.o.
Prof. Igor Muševič

VISITORS FROM ABROAD

1. Dr. Hae Jin Kim, Nano-Energy Materials Team, Korea Basic Science Institute, Daejeon, South Korea, 1. 3. 2012–28. 2. 2013
2. Dr. Adam Ostrowski, Poland, EUPP7 project “ESR-STM”, 1. 11. 2012–31. 10. 2013
3. Mag. Venkata Subba Rao Jampani, India, EU Marie-Curie, 1. 11. 2009–15. 7. 2013
4. Maryam Nikkhou, Iran, EU Marie-Curie, 1. 6. 2012–31. 12. 2013
5. Dr. Anna Ryzhkova, Russia, EU project Marie-Curie, 1. 6. 2012–31. 1. 2013
6. Dr. Mirta Herak, Institute of Physics, Zagreb, Croatia, 4.–5. 1. 2013
7. Silvio Preda, Ilie Murguescu Institute of Physical Chemistry of the Romanian Academy, Bucharest, Romania, 14.–25. 1. 2013
8. Prof. Yishay Manassen, Ben Gurion University, Beer Sheva, Israel, 5.–12. 2., 17. 9. 2013
9. Prof. David Sherrington, University of Oxford, Oxford, Great Britain, 13.–14. 2. 2013
10. Dr. Sanjiv Sonkaria, Dr. Varsha Khare, Seoul National University, Kwanak, Seoul, South Korea, 15.–30. 3. 2013
11. Prof. Horst Beige, Martin-Luther Universitaet, Halle, Germany, 18. 3. 2013–21. 3. 2013
12. Dr. Magdalena Wencka, Polish Academy of Sciences, Institute of Molecular Physics, Poznan, Poland, 3. 4.–30. 4., 23. 11.–15. 12. 2013
13. Prof. Luigi Colombo, Texas Instruments Incorporated, Texas, USA, 9. 4. 2013
14. Dr. Shehab Mansour Hassan, University of Menofia, Menofia, Egypt, 14. 4.–27. 4. 2013
15. Dr. Giorgio Mirri, Italy, EU Marie-Curie project, 6. 5. 2013–6. 5. 2015
16. Nerea Sebastian Ugarteche, Universidad del Pais Vasco UPV/EHU, Leioa, Spain, 16. 4.–3. 6. 2013
17. Prof. Wilfried Schranz, University of Vienna, Faculty of Physics, Vienna, Austria, 27. 5.–30. 5. 2013
18. Dr. Hae Jin Kim, Korea Basic Science Institute, Nano-Energy Materials Team, Daejeon, South Korea, 22. 6.–29. 6., 30. 11.–15. 12. 2013
19. Dr. Jin Bae Lee, Korea Basic Science Institute, Nano-Energy Materials Team, Daejeon, South Korea, 19. 6.–28. 8. 2013
20. Dr. Valentina Domenici, Universita di Pisa, Pisa, Italy, 15. 7.–15. 8. 2013
21. Donatella Ancora, Universita di Pisa, Pisa, Italy, 15. 6.–15. 10. 2013
22. Mutsuo Igarashi, Gunma National College of Technology, Maebashi, Japan, 5. 8.–22. 9., 12. 10.–12. 11., 28. 11.–27. 12. 2013
23. Dr. RamaRao Partibho, Raman Research Institute, Bangalore, India, 7. 9.–21. 9. 2013.
24. Dr. Takehito Nakano, University of Osaka, Toyonaka, Osaka, Japan, 8. 9.–13. 9. 2013.
25. Prof. Qiming Zhang, University of Pennsylvania State, Pennsylvania, USA, 18.–21. 9. 2013
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BIBLIOGRAPHY

ORIGINAL ARTICLE

- Andreja Abina, Uroš Puc, Anton Jeglič, Aleksander Zidanšek, "Structural analysis of insulating polymer foams with terahertz spectroscopy and imaging", *Polym. test.*, vol. 32, issue 4, pp. 739-747, 2013.
- Denis Arčon, Kristjan Anderle, Martin Klanjšek, A. Sans, C. Mühle, P. Adler, W. Schnelle, M. Jansen, C. Felser, "Influence of O₂ molecular orientation on p-orbital ordering and exchange pathways in Cs₄O₆", *Phys. rev., B, Condens. matter mater. phys.*, vol. 88, no. 22, pp. 224409-1-224409-7, 2013.
- Denis Arčon, Andrej Zorko, Peter Jeglič, Jingtao Xu, Jun Tang, Yoichi Tanabe, Satoshi Heguri, Katsumi Tanigaki, "Rattler site selectivity and covalency effects in type-I clathrates", *J. Phys. Soc. Jpn.*, vol. 82, no. 1, pp. 014703-1-014703-6, 2013.
- Franci Bajd, Igor Serša, "Mathematical modeling of blood clot fragmentation during flow-mediated thrombolysis", *Biophys. j.*, vol. 104, no. 5, pp. 1181-1190, 2013.
- Nina Bizjak, Franci Bajd, Jernej Vidmar, Aleš Blinc, Victor J. Marder, Valery Novokhatny, Igor Serša, "Comparison of local thrombolytic efficacy of plasmin and rt-PA in an in-vitro flow system: a pilot study", *Blood coagul. fibrinolysis*, vol. 24, no. 7, pp. 711-714, 2013.
- Vid Bobnar, Hana Uršič, Goran Casar, Silvo Drnovšek, "Distinctive contributions to dielectric response of relaxor ferroelectric lead scandium niobate ceramic system", *Phys. status solidi, b Basic res.*, vol. 250, no. 10, pp. 2232-2236, 2013.
- Abdelhamid Boudiba, Chao Zhang, Polona Umek, Carla Bittencourt, Rony Snyders, Marie-Georges Olivier, Marc Debliquy, "Sensitive and rapid hydrogen sensors based on PdWO₃ thick films with different morphologies", *Int. j. hydrogen energy*, vol. 38, no. 5, pp. 2565-2577, 2013.
- Mojca Božič, Janez Štrancar, Vanja Kokol, "Laccase-initiated reaction between phenolic acids and chitosan", *React. funct. polym.*, vol. 73, iss. 10, pp. 1377-1383, Oct. 2013.
- Ivan Brnardić, Miroslav Huskić, Polona Umek, Alberto Fina, Tamara Holjevac-Grgurić, "Synthesis of silane functionalized sodium titanate nanotubes and their influence on thermal and mechanical properties of epoxy nanocomposite", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, no. 11, pp. 2284-2291, 2013.
- Ivan Brnardić, Miroslav Huskić, Polona Umek, Tamara Holjevac-Grgurić, "Sol-gel functionalization of sodium TiO₂ nanotubes and nanoribbons with aminosilane molecules", *Ceram. int.*, vol. 39, iss. 8, pp. 9459-9464, Dec. 2013.
- E. Canevet, B. Grenier, Martin Klanjšek, Claude Berthier, Mladen Horvatić, Virginie Simonet, P. Lejay, "Field-induced magnetic behavior in quasi-one-dimensional Ising-like antiferromagnet BaCo₂V₂O₈: a single-crystal neutron diffraction study", *Phys. rev., B, Condens. matter mater. phys.*, vol. 87, no. 5, pp. 054408-1-054408-15, 2013.
- Goran Casar, Xinyu Li, Jurij Koruza, Qiming M. Zhang, Vid Bobnar, "Electrical and thermal properties of vinylidene fluoride-trifluoroethylene-based polymer system with coexisting ferroelectric and relaxor states", *J. Mater. Sci.*, vol. 48, no. 22, pp. 7920-7926, 2013.
- Marcello Cavallaro, Mohamed Amine Gharbi, Daniel A. Beller, Simon Čopar, Zheng Shi, Tobias Baumgart, Shu Yang, Randall D. Kamien, Kathleen J. Stebe, "Exploiting imperfections in the bulk to direct assembly of surface colloids", *Proc. Natl. Acad. Sci. U. S. A.*, vol. 110, no. 47, pp. 18804-18808, 2013.
- Marcello Cavallaro, Mohamed Amine Gharbi, Daniel A. Beller, Simon Čopar, Zheng Shi, Randall D. Kamien, Shu Yang, Tobias Baumgart, Kathleen J. Stebe, "Ring around the colloid", *Soft matter*, vol. 9, iss. 38, pp. 9099-9102, 2013.
- Cesare Chiccoli, Paolo Pasini, Gregor Skačej, Claudio Zannoni, Slobodan Žumer, "Chirality transfer from helical nanostructures to nematics: a Monte Carlo study", *Mol. Cryst. Liq. Cryst. (Phila. Pa.: 2003)*, vol. 576, iss. 1, pp. 151-156, 2013.
- George Cordoyannis *et al.* (16 authors), "Different modulated structures of topological defects stabilized by adaptive targeting nanoparticles", *Soft matter*, vol. 9, no. 15, pp. 3956-3964, 2013.
- Simon Čopar, Noel Anthony Clark, Miha Ravnik, Slobodan Žumer, "Elementary building blocks of nematic disclination networks in densely packed 3D colloidal lattices", *Soft matter*, vol. 9, iss. 34, pp. 8203-8209, 2013.
- Simon Čopar, Mark R. Dennis, Randall D. Kamien, Slobodan Žumer, "Singular values, nematic disclinations, and emergent biaxiality", *Phys. rev., E Stat. nonlinear soft matter phys.*, vol. 87, iss. 5, pp. 050504-1-050504-5, 2013.
- Simon Čopar, Tine Porenta, Slobodan Žumer, "Visualisation methods for complex nematic fields", *Liq. Cryst.*, vol. 40, iss. 12, pp. 1759-1768, 2013.
- Simon Čopar, Slobodan Žumer, "Quaternions and hybrid nematic disclinations", *Proc. - Royal Soc., Math. phys. eng. sci.*, vol. 469, no. 2156, 10 pp., 2013.
- Janez Diaci, Cene Filipič, Tadej Perhavec, Matjaž Lukač, "Influence of water absorption shift on ablation speed of Er:YAG and Er,Cr:YSGG dental lasers", *LAHA*, vol. 2013, no. 1, pp. 17-22, 2013.
- Sara Dolci, Vincenzo Ieraldi, Anton Gradišek, Zvonko Jagličič, Maja Remškar, Tomaž Apih, Mario Cifelli, Guido Pampaloni, Carlo Alberto Veracini, Valentina Domenici, "Precursors of magnetic resonance imaging contrast agents based on cystine-coated iron-oxide nanoparticles", *Current physical chemistry*, vol. 3, no. 4, pp. 493-500, 2013.
- Sara Dolci *et al.* (9 authors), "Chemical-physical properties, morphology, and magnetic investigations on new cystine functionalized ultra-small super-paramagnetic iron-oxide nanoparticles", *J. Mater. Sci.*, vol. 48, iss. 3, pp. 1283-1291, 2013.
- Cene Filipič, Adrijan Levstik, "Polaronic behavior of La_{0.8}Te_{0.2}MnO₃", *Journal of advanced dielectrics*, vol. 3, no. 4, pp. 1320002-1-1320002-3, 2013.
- Cene Filipič, Adrijan Levstik, Dušan Hadži, "Polarons in crystalline perfluorotetradecanoic acid monohydrate", *J. appl. phys.*, vol. 113, no. 17, pp. 173705-1-173705-4, 2013.
- Cene Filipič, Gašper Tavčar, Evgeny A. Goreshnik, Boris Žemva, Adrijan Levstik, "Polarons in magnetoelectric fluorides", In: Proceedings of the 7th Seminar on Ferroelastic Physics, 10-13 September, 2012, Voronezh, Russia, *Ferroelectrics*, vol. 444, no. 1, pp. 190-198, 2013.
- Nenad Filipović, Marija Borna, Olivera Klisurić, Matej Pregelj, Marko Jagodič, Katarina Anđelković, Tamara Todorović, "Synthesis, characterization, and thermal behavior of Cu(II) and Zn(II) complexes with (E)-2-[N'-(1-pyridin-2-yl-ethylidene)hydrazino]acetic acid (aphaOH). Crystal structure of [Zn₂(aphaO)₂Cl₂]", *J. coord. chem.*, vol. 66, no. 9, pp. 1549-1560, 2013.
- Jun-ichi Fukuda, Slobodan Žumer, "Field-induced dynamics and structures in a cholesteric-blue-phase cell", *Phys. rev., E Stat. nonlinear soft matter phys.*, vol. 87, iss. 4, pp. 042506-1-042506-12, 2013.
- Yong Geng, David Seč, Pedro L. Almeida, Oleg D. Lavrentovich, Slobodan Žumer, Maria H. Godinho, "Liquid crystal necklaces: cholesteric drops threaded by thin cellulose fibres", *Soft matter*, vol. 9, iss. 33, pp. 7928-7933, 2013.
- Mohamed Amine Gharbi, David Seč, Teresa Lopez-Leon, Maurizio Nobili, Miha Ravnik, Slobodan Žumer, Christophe Blanc, "Microparticles confined to a nematic liquid crystal shell", *Soft matter*, vol. 9, issue 29, pp. 6911-6920, 2013.
- Anton Gradišek, Tomaž Apih, Valentina Domenici, Vladimíra Novotná, Pedro J. Sebastião, "Molecular dynamics in a blue phase liquid crystal: a ¹H fast field-cycling NMR relaxometry study", *Soft matter*, vol. 9, no. 45, pp. 10746-10753, 2013.
- Anton Gradišek, Dorthe Ravnsbæk, Stanislav Vrtnik, Andraž Kocjan, Janez Lužnik, Tomaž Apih, Torben R. Jensen, Alexander V. Skripov, Janez Dolinšek, "NMR study of molecular dynamics in complex metal borohydride LiZn₂(BH₄)₅", *The journal of physical chemistry. C, Nanomaterials and interfaces*, vol. 117, no. 41, pp. 21139-21147, 2013.
- Francesco Greco, Valentina Domenici, Andrea Desii, Edoardo Sinibaldi, Blaž Zupančič, Boštjan Zalar, Barbara Mazzolai, Virgilio Mattoli, "Liquid single crystal elastomer/conducting polymer bilayer composite actuator: modelling and experiments", *Soft matter*, vol. 47, no. 9, pp. 11405-11416, 2013.
- Francesco Greco, Valentina Domenici, Stefano Romiti, Tareq Assaf, Blaž Zupančič, Jerneja Milavec, Boštjan Zalar, Barbara Mazzolai, Virgilio Mattoli, "Reversible heat-induced microwrinkling of PEDOT:PSS nanofilm surface over a monodomain liquid crystal elastomer", In: Proceedings of the 10th Italian Liquid Crystals Society, SICL 2012, 21st-23rd June, 2012, Rome, Italy, *Mol. Cryst. Liq. Cryst.*, vol. 572, no. 1, pp. 40-49, 2013.
- Alan Gregorovič, Tomaž Apih, "WURST-QCPMG sequence and "spin-lock" in ¹⁴N nuclear quadrupole resonance", *J. magn. reson. (San Diego, Calif., 1997: Print)*, vol. 233, pp. 96-102, 2013.
- Igor Gvozdevskyy, Venkata Subba R. Jampani, Miha Škarabot, Igor Muševič, "Light-induced rewiring and winding of Saturn ring defects in

- photosensitive chiral nematic colloids", *The European physical journal. E, Soft matter*, vol. 36, no. 9, pp. 97-1-97-8, 2013.
37. Mirta Herak, Andrej Zorko, Matej Pregelj, Oksana Zaharko, Gregor Posnjak, Zvonko Jagličič, Anton Potočnik, H. Luetkens, J. van Tol, Andrzej Ozarowski, Helmut Berger, Denis Arčon, "Magnetic order and low-energy excitations in the quasi-one-dimensional antiferromagnet CuSe_2O_5 with staggered fields", *Phys. rev. B, Condens. matter mater. phys.*, vol. 87, no. 10, pp. 104413-1-104413-12, 2013.
 38. Julia Hurler, Simon Žakelj, Janez Mravljak, Stane Pajk, Albin Kristl, Rolf Schubert, Nataša Škalko-Basnet, "The effect of lipid composition and liposome size on the release properties of liposomes-in-hydrogel", *Int. j. pharm.*, vol. 456, iss. 1, pp. 49-57, 2013.
 39. Miroslav Huskić, Tamara Holjevac-Grgurić, Polona Umek, Ivan Brnardić, "Functionalization of sodium titanate nanoribbons with silanes and their use in the reinforcement of epoxy nanocomposites", *Polym. compos.*, vol. 34, no. 8, pp. 1382-1388, 2013.
 40. Wan Sik Hwang *et al.* (10 authors), "Comparative study of chemically synthesized and exfoliated multilayer MoS_2 field-effect transistors", *Appl. phys. lett.*, vol. 102, no. 4, pp. 043116-1-043116-3, 2013.
 41. Mutsuo Igarashi *et al.* (11 authors), "NMR study of thermally activated paramagnetism in metallic low-silica X zeolite filled with sodium atoms", *Phys. rev. B, Condens. matter mater. phys.*, vol. 87, no. 7, pp. 075138-1-075138-7, 2013.
 42. Zvonko Jagličič, Damir Pajić, Zvonko Trontelj, Janez Dolinšek, Marko Jagodič, "Magnetic memory effect in multiferroic $\text{K}_3\text{Fe}_5\text{F}_{15}$ and $\text{K}_3\text{Cr}_2\text{Fe}_3\text{F}_{15}$ ", *Appl. phys. lett.*, vol. 102, no. 24, pp. 242410-1-242410-4, 2013.
 43. Venkata Subba R. Jampani, Matjaž Humar, Igor Mušević, "Resonant transport of light from planar polymer waveguide into liquid-crystal microcavity", *Opt. express*, vol. 21, iss. 18, pp. 20506-20516, 2013.
 44. Venkata Subba R. Jampani, Miha Škarabot, Simon Čopar, Slobodan Žumer, Igor Mušević, "Chirality screening and metastable states in chiral nematic colloids", *Phys. rev. lett.*, vol. 110, no. 17, pp. 177801-1-177801-5, 2013.
 45. Venkata Subba R. Jampani, Miha Škarabot, Hideo Takezoe, Igor Mušević, Surajit Dhara, "Laser-driven microflow-induced bistable orientation of a nematic liquid crystal in perfluoropolymer-treated unribbed cells", *Opt. express*, vol. 21, no. 1, pp. 724-729, 2013.
 46. Biljana Janković, Jan Pelipenko, Miha Škarabot, Igor Mušević, Julijana Kristl, "The design trend in tissue-engineering scaffolds based on nanomechanical properties of individual electrospun nanofibers", *Int. j. pharm.*, vol. 455, iss. 1/2, pp. 338-347, 2013.
 47. Biljana Janković, Miha Škarabot, Zoran Lavrič, Ilija Ilić, Igor Mušević, Stanko Srčić, Odon Planinšek, "Consolidation trend design based on Young's modulus of clarithromycin single crystals", *Int. j. pharm.*, vol. 454, iss. 1, pp. 324-332, 2013.
 48. Dalija Jesenek, Šárka Perutková, Wojciech Gózdź, Veronika Kralj-Iglič, Aleš Iglič, Samo Kralj, "Vesiculation of biological membrane driven by curvature induced frustrations in membrane orientational ordering", *International journal of nanomedicine*, vol. 8, no. 1, pp. 677-687, 2013.
 49. Mitjan Kalin, Janez Kogovšek, Maja Remškar, "Nanoparticles as novel lubricating additives in a green, physically based lubrication technology for DLC coatings", *Wear*, vol. 303, iss. 1/2, pp. 480-485, Jun. 2013.
 50. Martin Klanjšek, Simon Jazbec, Michael Feuerbacher, Janez Dolinšek, "Physical properties of the V-Al₅Cu₆Mg₂ complex intermetallic phase", *Intermetallics (Barking)*, vol. 39, pp. 50-57, 2013.
 51. Janez Kogovšek, Maja Remškar, Mitjan Kalin, "Lubrication of DLC-coated surfaces with MoS_2 nanotubes in all lubrication regimes: surface roughness and running-in effects", *Wear*, vol. 303, iss. 1/2, pp. 361-370, Jun. 2013.
 52. Janez Kogovšek, Maja Remškar, Aleš Mrzel, Mitjan Kalin, "Influence of surface roughness and running-in on the lubrication of steel surfaces with oil containing MoS_2 nanotubes in all lubrication regimes", *Tribol. int.*, vol. 61, pp. 40-47, May 2013.
 53. Mitja Kolenc, Eloy Gonzalez Ortega, Faysal Basci, Jurij F. Tasič, Matej Zajc, "Intelligent monitoring of power networks - system architecture and communication network infrastructure", *Elektrotehniški vestnik*, vol. 80, no. 5, pp. 245-250, 2013.
 54. Primož Koželj, Simon Jazbec, Stanislav Vrtnik, Andreja Jelen, Janez Dolinšek, Marko Jagodič, Zvonko Jagličič, P. Boulet, M. C. de Weerd, J. Ledieu, J. M. Dubois, V. Fournée, "Geometrically frustrated magnetism of spins on icosahedral clusters: the $\text{Gd}_3\text{Au}_{13}\text{Sn}_4$ quasicrystalline approximant", *Phys. rev. B, Condens. matter mater. phys.*, vol. 88, no. 21, pp. 214202-1-214202-21, 2013.
 55. Samo Kralj, Dalija Jesenek, George Cordoyiannis, Gojmir Lahajnar, Zdravko Kutnjak, "Memory-controlled smectic wetting of liquid crystals confined to controlled-pore matrices", In: Special issue of the 18th Symposium on Thermophysical Properties, June 24-29, 2012, Boulder, Colorado, USA, *Fluid Phase Equilib.*, vol. 351, pp. 87-93, 2013.
 56. Marta Lavrič, George Cordoyiannis, Samo Kralj, Vassilios Tzitzios, George Nounesis, Zdravko Kutnjak, "Effect of anisotropic MoS_2 nanoparticles on the blue phase range of a chiral liquid crystal", *Applied optics*, vol. 52, no. 22, pp. E47-E52, 2013.
 57. Marta Lavrič, Vassilios Tzitzios, Samo Kralj, George Cordoyiannis, Ioannis Lelidis, George Nounesis, V. Georgakilas, Heinz Amenitsch, Aleksander Zidanšek, Zdravko Kutnjak, "The effect of graphene on liquid-crystalline blue phases", *Appl. phys. lett.*, vol. 103, no. 14, pp. 143116-1-143116-4, 2013.
 58. Hyun Uk Lee *et al.* (12 authors), "Sea-urchin-like iron oxide nanostructures for water treatment", *J. hazard. mater.*, vol. 262, pp. 130-136, 2013.
 59. Marko Likon, Maja Remškar, Vilma Ducman, Franc Švegl, "Populus seed fibers as a natural source for production of oil super absorbents", *J. environ. manag.*, vol. 114, pp. 158-167, Jan. 2013.
 60. Nina Lopič, Andreja Jelen, Stanislav Vrtnik, Zvonko Jagličič, Magdalena Wencka, Radovan Starc, Aleš Blinc, Janez Dolinšek, "Quantitative determination of magnetic force on a coronary stent in MRI", *J. magn. reson. imaging*, vol. 37, no. 2, pp. 391-397, 2013.
 61. R. Mackevičute, M. Ivanov, J. Banyš, Nikola Novak, Zdravko Kutnjak, Magdalena Wencka, James Floyd Scott, "The perfect soft mode: giant phonon instability in a ferroelectric", *J. phys., Condens. matter*, vol. 25, issue 21, pp. 212201-1-212201-5, 2013.
 62. Rinku Majumder, Tilen Koklič, Alireza R. Rezaie, Barry R. Lentz, "Phosphatidylserine-induced factor Xa dimerization and binding to Factor Va are competing processes in solution", *Biochemistry (Easton)*, vol. 52, issue 1, pp. 143-151, 2013.
 63. Olga Malgina, Aleš Pražnikar, Jurij F. Tasič, "Inhomogeneity correction and fat-tissue extraction in MR images of FacioScapuloHumeral muscular Dystrophy", *Pattern recogn. lett.*, vol. 34, no. 12, pp. 1364-1371, 2013.
 64. Jana Milenković, Kristijana Hertl, Andrej Košir, Janez Žibert, Jurij F. Tasič, "Characterization of spatiotemporal changes for the classification of dynamic contrast-enhanced magnetic-resonance breast lesions", *Artif. intell. med.*, iss. 2, vol. 58, pp. 101-114, 2013.
 65. Agron Millaku, Damjana Drobne, Matjaž Torkar, Sara Novak, Maja Remškar, Živa Pipan Tkalec, "Use of scanning electron microscopy to monitor nanofibre/cell interaction in digestive epithelial cells", *J. hazard. mater.*, vol. 260, pp. 47-52, 15. Sep. 2013.
 66. Aleksandra Milutinović Živin, Ruda Zorc-Pleskovič, Marko Živin, Andrej Vovk, Igor Serša, Dušan Šuput, "Magnetic resonance imaging for rapid screening for the nephrotoxic and hepatotoxic effects of microcystins", *Mar. drugs*, vol. 11, no. 8, pp. 2785-2798, 2013.
 67. Jana Mlakar, Janez Štrancar, "Temperature and humidity profiles in passive-house building blocks", *Build. environ.*, vol. 60, pp. 185-193, 2013.
 68. Janez Mravljak, Tadej Ojsteršek, Stane Pajk, Marija Sollner Dolenc, "Coumarin-based dual fluorescent spin-probes", *Tetrahedron lett.*, vol. 54, iss. 38, pp. 5236-5238, 2013.
 69. Igor Mušević, "Nematic colloids, topology and photonics", *Philos. trans. R. Soc. Lond., A*, vol. 371, no. 1988, pp. 20120266-1-20120266-15, 2013.
 70. Nikola Novak, Zdravko Kutnjak, "Hysteresis of field-induced ferroelectric transition in $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ relaxor ferroelectrics", In: Proceedings of the ISAF ECAPD PMF 2012, International Symposium on Applications of Ferroelectrics; European Conference on the Applications of Polar Dielectrics; International Symposium Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials, 9-13 of July, 2012, Aveiro, Portugal, *Ferroelectrics*, vol. 447, no. 1, pp. 40-45, 2013.
 71. Nikola Novak, Zdravko Kutnjak, Raša Pirc, "High-resolution electrocaloric and heat capacity measurements in barium titanate", *Europhys. lett.*, vol. 103, no. 4, pp. 47001-1-47001-5, 2013.
 72. Nikola Novak, Raša Pirc, Zdravko Kutnjak, "Diffuse critical point in PLZT ceramics", *Europhys. lett.*, vol. 102, no. 1, pp. 17003-1-17003-5, 2013.
 73. Nikola Novak, Raša Pirc, Zdravko Kutnjak, "Impact of critical point on piezoelectric and electrocaloric response in barium titanate", *Phys. rev. B, Condens. matter mater. phys.*, vol. 87, vol. 10, pp. 104102-1-104102-5, 2013.
 74. Sara Novak, Damjana Drobne, Lisa Vaccari, Maya Petrova Kiskinova, Paolo Ferraris, Giovanni Birarda, Maja Remškar, Matej Hočevar, "Effect of ingested tungsten oxide (WOX) nanofibers on digestive gland tissue of Porcellio scaber (Isopoda, Crustacea): fourier transform infrared (FTIR) imaging", *Environ. sci. technol.*, vol. 47, no. 19, pp. 11284-11292, 2013.

75. Andriy Nych, Ulyana Ognysta, Miha Škarabot, Miha Ravnik, Slobodan Žumer, Igor Mušević, "Assembly and control of 3D nematic dipolar colloidal crystals", *Nature communications*, vol. 4, pp. 1489-1-1489-8, 2013.
76. Ante Odić, Marko Tkalič, Jurij F. Tasič, Andrej Košir, "Impact of the context relevancy on ratings prediction in a movie-recommender system", *Automatika (Zagreb)*, vol. 54, no. 2, pp. 252-262, 2013.
77. Ante Odić, Marko Tkalič, Jurij F. Tasič, Andrej Košir, "Predicting and detecting the relevant contextual information in a movie-recommender system", *Interact. comput.*, vol. 25, no. 1, pp. 74-90, 2013.
78. Karthik Peddireddy, Venkata Subba R. Jampani, Shashi Thutupalli, Stephan Herminghaus, Christian Bahr, Igor Mušević, "Lasing and waveguiding in smectic A liquid crystal optical fibers", *Opt. express*, vol. 21, no. 25, pp. 30233-30242, 2013.
79. Matej Pregelj, Peter Jeglič, Andrej Zorko, Oksana Zaharko, Tomaž Apih, Anton Gradišek, Matej Komelj, Helmuth Berger, Denis Arčon, "Evolution of magnetic and crystal structures in the multiferroic $\text{FeTe}_2\text{O}_5\text{Br}$ ", *Phys. rev., B, Condens. matter mater. phys.*, vol. 87, no. 14, pp. 144408-1-144408-8, 2013.
80. Matej Pregelj, Andrej Zorko, Oksana Zaharko, Peter Jeglič, Zdravko Kutnjak, Zvonko Jagličič, Simon Jazbec, H. Luetkens, A. D. Hillier, Helmuth Berger, Denis Arčon, "Multiferroicity in the geometrically frustrated $\text{FeTe}_2\text{O}_5\text{Cl}$ ", *Phys. rev., B, Condens. matter mater. phys.*, vol. 88, no. 22, pp. 224421-1-224421-10, 2013.
81. Albert Prodan, Herman J. P. van Midden, Erik Zupanič, Rok Žitko, "Nanostructured and modulated low-dimensional systems", In: Proceedings of the XXII Conference on Applied Crystallography, 2-6 September 2012, Targanice, Poland, *Solid State Phenom.*, vol. 203-204, pp. 42-47, 2013.
82. Denis Rajh, Sergii Shelestiuk, Alenka Mertelj, Aleš Mrzel, Polona Umek, Silvia Irusta, A. Zak, Irena Drevenšek Olenik, "Effect of inorganic 1D nanoparticles on electrooptic properties of 5CB liquid crystal", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, no. 11, pp. 2328-2334, 2013.
83. Amid Ranjkesh Siahkal, Milan Ambrožič, George Cordoyiannis, Zdravko Kutnjak, Samo Kralj, "History-dependent patterns in randomly perturbed nematic liquid crystals", *Adv. Condens. Matter Phys.*, vol. 2013, pp. 505219-1-505219-10, 2013.
84. Maja Remškar, Ivan Iskra, Janez Jelenc, Srečo D. Škapin, Bojana Višič, Ana Varlec, Andrej Kržan, "A novel structure of polyvinylidene fluoride (PVDF) stabilized by MoS_2 nanotubes", *Soft matter*, vol. 9, no. 36, pp. 8647-8653, 2013.
85. Maja Remškar, Janez Jelenc, Bojana Višič, Ana Varlec, Maja Češarek, Andrej Kržan, "Friction properties of polyvinylidene fluoride with added MoS_2 nanotube", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, no. 11, pp. 2314-2319, 2013.
86. Robert Repnik, Amid Ranjkesh Siahkal, Vito Šimonka, Milan Ambrožič, Zlatko Bradač, Samo Kralj, "Symmetry breaking in nematic liquid crystals: analogy with cosmology and magnetism", *J. phys., Condens. matter*, vol. 25, no. 40, pp. 404201-1-404201-10, 2013.
87. Brigita Rožič, Marko Jagodič, Sašo Gyergyek, Zvonko Jagličič, Samo Kralj, Vassilios Tzitzios, George Cordoyiannis, Zdravko Kutnjak, "Indirect magnetoelectric coupling in mixtures of magnetite and ferroelectric liquid crystal", In: Proceedings of the ISAF ECAPD PMF 2012, International Symposium on Applications of Ferroelectrics; European Conference on the Applications of Polar Dielectrics; International Symposium Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials, 9-13 of July, 2012, Aveiro, Portugal, *Ferroelectrics*, vol. 448, no. 1, pp. 12-16, 2013.
88. Brigita Rožič, Jurij Koruza, Zdravko Kutnjak, George Cordoyiannis, Barbara Malič, Marija Kosec, "The electrocaloric effect in lead-free $\text{K}_{0.5}\text{Na}_{0.5}\text{NbO}_3 - \text{SrTiO}_3$ ceramics", In: Proceedings of the ISAF ECAPD PMF 2012, International Symposium on Applications of Ferroelectrics; European Conference on the Applications of Polar Dielectrics; International Symposium Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials, 9-13 of July, 2012, Aveiro, Portugal, *Ferroelectrics*, vol. 446, no. 1, pp. 39-35, 2013.
89. Mitja Ruprecht, Vladimir Jevtič, Igor Serša, Matjaž Vogrin, Marko Jevšek, "Evaluation of the tibial tunnel after intraoperatively administered platelet-rich plasma gel during anterior cruciate ligament reconstruction using diffusion weighted and dynamic contrast-enhanced MRI", *J. magn. reson. imaging*, vol. 37, no. 4, pp. 928-935, 2013.
90. Anna V. Ryzhkova, Igor Mušević, "Particle size effects on nanocolloidal interactions in nematic liquid crystals", *Phys. rev., E Stat. nonlinear soft matter phys.*, vol. 87, no. 3, pp. 032501-1-032501-12, 2013.
91. Janez Seliger, Veselko Žagar, "Crystallization of an amorphous solid studied by nuclear quadrupole double resonance", *Chem. phys.*, vol. 421, pp. 44-48, 2013.
92. Janez Seliger, Veselko Žagar, "Hydrogen bonds in cocrystals and salts of 2-amino-4,6-dimethylpyrimidine and carboxylic acids studied by nuclear quadrupole resonance", *J. phys. chem., B Condens. mater. surf. interfaces biophys.*, vol. 117, iss. 23, pp. 6946-6956, 2013.
93. Janez Seliger, Veselko Žagar, "Nuclear quadrupole resonance study of hydrogen bonds in solid 2-methylbenzimidazole and 5, 6-dimethylbenzimidazole", *The journal of physical chemistry. C, Nanomaterials and interfaces*, vol. 117, iss. 39, pp. 20193-20200, 2013.
94. Janez Seliger, Veselko Žagar, "Tautomerism and possible polymorphism in solid hydroxypyridines and pyridones studied by ^{14}N NQR", *J. phys. chem., A Mol. spectrosc. kinet. environ. gen. theory*, vol. 117, iss. 7, pp. 1651-1658, 2013.
95. Janez Seliger, Veselko Žagar, Tetsuo Asaji, "NQR investigation and characterization of cocrystals and crystal polymorphs", In: Proceedings of the 4th Joint International Conference on Hyperfine Interactions and International Symposium on Nuclear Quadrupole Interactions (HFI/NQI 2012), Beijing, China, 10-14 September 2012, *Hyperfine Interact.*, vol. 222, iss. 1/3, pp. 1-13, 2013.
96. Janez Stepišnik, Gojmir Lahajnar, Ivan Zupančič, Aleš Mohorič, "Study of translational dynamics in molten polymer by variation of gradient pulse-width of PGSE", *J. magn. reson. (San Diego, Calif., 1997: Print)*, vol. 236, pp. 41-46, 2013.
97. Miha Škarabot, Žiga Lokar, Igor Mušević, "Transport of particles by a thermally induced gradient of the order parameter in nematic liquid crystals", *Phys. rev., E Stat. nonlinear soft matter phys.*, vol. 87, no. 6, pp. 062501-1-062501-6, 2013.
98. Ajda Taler-Verčič *et al.* (13 authors), "The role of initial oligomers in amyloid fibril formation by human stefin B", *Int. j. mol. sci.*, vol. 14, no. 9, pp. 18362-18384, 2013.
99. Angelos Thanassoulas, Eva Karatairi, George Cordoyiannis, Zdravko Kutnjak, Vassilios Tzitzios, Ioannis Lelidis, George Nounesis, "CdSe nanoparticles dispersed in ferroelectric smectic liquid crystals: Effects upon the smectic order and the smectic-A to chiral smectic-C phase transition", *Phys. rev., E Stat. nonlinear soft matter phys.*, vol. 88, no. 3, pp. 032504-1-032504-8, 2013.
100. Marko Tkalič, Andrej Košir, Jurij F. Tasič, "The LDOS-PerAff-1 corpus of facial-expression video clips with affective, personality and user-interaction metadata", *J. Multimodal User Interfaces (Print)*, vol. 7, no. 1/2, pp. 143-155, Mar. 2013.
101. Marko Tkalič, Ante Odić, Andrej Košir, Jurij F. Tasič, "Affective labeling in a content-based recommender system for images", *IEEE trans. multimedia*, vol. 15, no. 2, pp. 391-400, Feb. 2013.
102. Iztok Urbančič, Zoran Arsov, Ajasja Ljubetič, Daniele Biglino, Janez Štrancar, "Bleaching-corrected fluorescence microspectroscopy with nanometer peak position resolution", *Opt. express*, vol. 21, no. 21, pp. 25291-25306, 2013.
103. Iztok Urbančič, Ajasja Ljubetič, Zoran Arsov, Janez Štrancar, "Coexistence of probe conformations in lipid phases: a polarized fluorescence microspectroscopy study", *Biophys. j.*, vol. 105, no. 4, pp. 919-927, 2013.
104. Stella Vallejos, Polona Umek, Toni Stoycheva, Fatima Annanouch, Eduard Llobet, Xavier Correig, Patrizia De Marco, Carla Bittencourt, Christopher Blackman, "Single-step deposition of Au- and Pt-nanoparticle-functionalized tungsten oxide nanoneedles synthesized via aerosol-assisted CVD, and used for fabrication of selective gas microsensor arrays", *Adv. funct. mater.*, vol. 23, issue 10, pp. 1313-1322, 2013.
105. Ana Varlec, Shehab A. Mansour, Tiziana Di Luccio, Carmela Borriello, Annalisa Bruno, Janez Jelenc, Bojana Višič, Maja Remškar, "Microscopic and spectroscopic investigation of MoS_2 nanotubes/P3HT nanocomposites", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, issue 11, pp. 2335-2340, 2013.
106. Bojana Višič, Marta Klanjšek Gunde, Janez Kovač, Ivan Iskra, Janez Jelenc, Maja Remškar, " MoS_2 nanotube exfoliation as new synthesis pathway to molybdenum blue", *Mater. res. bull.*, vol. 48, issue 2, pp. 802-806, 2013.
107. Stanislav Vrtnik, Simon Jazbec, Marko Jagodič, Anže Korelec, Larisa Hosnar, Zvonko Jagličič, Peter Jeglič, Michael Feuerbacher, U. Mizutani, Janez Dolinšek, "Stabilization mechanism of $\gamma - \text{Mg}_{17}\text{Al}_{12}$ and $\beta - \text{Mg}_2\text{Al}_3$ complex metallic alloys", *J. phys., Condens. matter*, vol. 25, no. 42, pp. 425703-1-425703-14, 2013.
108. Oksana Zaharko, Matej Pregelj, Andrej Zorko, R. Podgajny, A. Gukasov, J. van Tol, S. I. Klokishner, S. Ostrovsky, B. Delley, "Source of magnetic anisotropy in quasi-two-dimensional XY $\{\text{Cu}_4(\text{tetrenH}_5)\text{W}(\text{CN})_8\}_n \cdot 7.2\text{H}_2\text{O}\}_n$ bilayer molecular magnet", *Phys. rev., B, Condens. matter mater. phys.*, vol. 87, no. 2, pp. 024406-1-024406-10, 2013.

109. Andrej Zorko, Fabris Bert, Andrzej Ozarowski, J. van Tol, D. Boldrin, Andrew S. Wills, Philippe Mendels, "Dzyaloshinsky-Moriya interaction in vesignieite: a route to freezing in a quantum kagome antiferromagnet", *Phys. rev. B, Condens. matter mater. phys.*, vol. 88, no. 14, pp. 144419-1-144419-7, 2013.
110. Maciej Zubko, Józef Kusz, Albert Prodan, Sašo Šturm, Herman J. P. van Midden, J. Craig Bennett, Grzegorz Dubin, Erik Zupanič, Horst Böhm, "Structural phase transition and related electronic properties in quasi-one-dimensional (NbSe₄)_{10/3}1", *Acta crystallogr., B Struct. sci.*, vol. 69, no. 3, pp. 229-237, 2013.
111. Blaž Zupančič, Boštjan Zalar, Maja Remškar, Valentina Domenici, "Actuation of gold-coated liquid crystal elastomers", *Appl. phys. express*, vol. 6, no. 2, pp. 021701-1-021701-4, 2013.

REVIEW ARTICLE

1. Uroš Tkalec, Igor Muševič, "Topology of nematic liquid crystal colloids confined to two dimensions", *Soft matter*, vol. 9, issue 34, pp. 8140-8150, 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

1. Venkata Subba R. Jampani, Matjaž Humar, Igor Muševič, "Resonant transfer of light from a planar waveguide into a tunable nematic liquid crystal microcavity", In: *Emerging liquid crystal technologies VIII: 5-6 February 2013, San Francisco, California, United States*, (Proceedings of SPIE, vol. 8642), Liang-Chy Chien, ed., Bellingham, SPIE, 2013, pp. 86420E-1-86420E-8.

PUBLISHED CONFERENCE CONTRIBUTION

1. Andreja Abina, Uroš Puc, Pavel Cevc, Anton Jeglič, Aleksander Zidanšek, "Terrestrial and underwater pollution-source detection using electromagnetic multisensory robotic system", In: *Proceedings of the 7th Conference on Sustainable Development of Energy, Water and Environmental Systems, July 1-7, 2012, Ohrid, Macedonia*, (Chemical engineering transactions, vol. 34, 2013), Milano, AIDIC, 2013, vol. 34, pp. 61-66, 2013.
2. Goran Casar, Jurij Koruza, Vid Bobnar, Xinyu Li, Qiming M. Zhang, "Nonlinear dielectric response of polymer system with coexisting ferroelectric and relaxor states", In: *2013 Joint UFFC, EFTF and PFM Symposium, International Ultrasonics Symposium (IUS), Joint IEEE International Symposium on the Applications of Ferroelectrics (ISAF) and Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials (PMF), Joint International Frequency Control Symposium (IFCS), and European Frequency and Time Forum (EFTF), 21-25 July 2013, Prague, Czech Republic* IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society International Ultrasonics Symposium (IUS), Joint IEEE International Symposium on the Applications of Ferroelectrics (ISAF) and Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials (PMF), Joint International Frequency Control Symposium (IFCS), and European Frequency and Time Forum (EFTF), 21-25 July 2013, Prague, Czech Republic, [S. l.], IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society, 2013, pp. 159-161.
3. Goran Casar, Xinyu Li, Jurij Koruza, Qiming M. Zhang, Vid Bobnar, "Electrical and thermal properties of polymer systems with coexisting ferroelectric and relaxor states", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 250-256.*
4. Miha Čančula, Miha Ravnik, Slobodan Žumer, "Modelling light propagation through optically non-uniform anisotropic materials", In: *Proceedings, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia*, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDE - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 67-70.
5. Štefan Dobravec, Jurij F. Tasič, "Simulacija pasivnega avtomatskega ostrenja satelitskega optičnega sistema za zajem slik", In: *Zbornik dvaindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2013, 16.-18. september 2013, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2013, zv. B, pp. 65-68.
6. Anton Gradišek, Matjaž Gams, "Uporaba inteligentnih mobilnih naprav za individualno medicinsko diagnostiko", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 51-54.
7. Mitja Kolenc, Emil Plesnik, Jurij F. Tasič, Matej Zajc, "Voltage notch detection and localization in power quality signals in phase space", In: *EUROCON 2013: Zagreb, Croatia, 1-4 July 2013*, Igor Kuzle, ed., Tomislav Capuder, ed., Hrvoje Pandžič, ed., Piscataway, IEEE, cop. 2013, pp. 1745-1751.
8. Primož Koželj, Simon Jazbec, Janez Dolinšek, "Electrical resistivity and magnetoresistance of the δ -FeZn₁₀ complex intermetallic phase", In: *Proceedings of the MRS Fall Meeting Symposim, MRS Fall Meeting, 24-29 November 2012, Boston, USA*, (MRS proceedings, vol. 1517), Warrendale, Materials Research Society, 2013, vol. 1517, 6 pp., 2013.
9. Matej Kranjc, Franci Bajd, Igor Serša, Damijan Miklavčič, "Magnetic resonance electrical impedance tomography for determining electric field distribution during electroporation", In: *XV International Conference on Electrical Bio-Impedance (ICEBI) & XIV Conference on Electrical Impedance Tomography (EIT): 22-25 April 2013, Heilbad Heiligenstadt, Germany*, (Journal of physics. Conference series (Online), vol. 434), Bristol, Institute of Physics Publishing, 2013, pp. 1-4.
10. Marko Meža, Jurij F. Tasič, Urban Burnik, "Telematic system in the blood transfusion service: usage analysis", In: *ICT innovations 2012: secure and intelligent systems*, (Advances in intelligent systems and computing, 207), Smile Markovski, ed., Berlin, Heidelberg, Springer-Verlag, 2013, pp. 173-182.
11. Urška Mikac, Saša Baumgartner, Ana Sepe, Julijana Kristl, "MRI study of hydrophilic xanthan tablets with incorporated model drug", In: *Proceedings of the 11th International Bologna Conference Magnetic Resonance in Porous Media (MRPM 11), September 2012, Surrey, UK*, (Diffusion fundamentals, Vol. 18, no. 2, 2013), Leipzig, J. Kärger c/o University of Leipzig, Faculty of Physics and Earth Science, 2013, vol. 18, no. 2, pp. 1-5, 2013.
12. Jerneja Milavec, "Raziskave tekočokristalnih elastomerov z jedrsko magnetno resonanco", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 323-330.*
13. Ante Odič, Marko Tkalič, Jurij F. Tasič, Andrej Košir, "Personality and social context: impact on emotion induction from movies", In: *UMAP 2013 extended proceedings: late-breaking results, project papers and workshop proceedings of the 21st Conference on User Modeling, Adaptation, and Personalization, Rome, Italy, June 10-14, 2013*, (CEUR workshop proceedings, vol. 997), UMAP 2013, Shlomo Berkovsky, ed., [S. l.], CEUR-WS, 2013, pp. [1-7].
14. Emil Plesnik, Olga Malgina, Jurij F. Tasič, Matej Zajc, "Improved removal of electrocardiogram baseline wandering", In: *EUROCON 2013: Zagreb, Croatia, 1-4 July 2013*, Igor Kuzle, ed., Tomislav Capuder, ed., Hrvoje Pandžič, ed., Piscataway, IEEE, cop. 2013, pp. 1764-1769.
15. Amid Ranjesh Siahkal, Milan Ambrožič, Samo Kralj, "Memory effects in randomly perturbed nematic liquid crystals", In: *World academy of science, engineering and technology. Iss. 75*, (World Academy of Science, Engineering and Technology, iss. 75, Mar. 2013), WASET 2013, March 28-29 2013, Madrid, Spain, [S. l.], World Academy of Science, Engineering and Technology, 2013, pp. 834-839.
16. Andraž Rihar, Matjaž Mihelj, Jurij F. Tasič, Marko Munih, "Zaznavanje delov telesa na podlagi kožne barve iz video posnetkov otrok", In: *Zbornik dvaindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2013, 16.-18. september 2013, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2013, zv. B, pp. 107-110.
17. Marko Tkalič, Urban Burnik, Ante Odič, Andrej Košir, Jurij F. Tasič, "Emotion-aware recommender systems: a framework and a case study", In: *ICT innovations 2012: secure and intelligent systems*, (Advances in intelligent systems and computing, 207), Smile Markovski, ed., Berlin, Heidelberg, Springer-Verlag, 2013, pp. 141-150.
18. Marko Vrabelj, Hana Uršič, Brigita Rožič, Zdravko Kutnjak, Silvo Drnovšek, Barbara Malič, "Electrocaloric properties of 0.7Pb(Mg_{1/3}Nb_{2/3})O₃ - 0.3PbTiO₃ ceramics", In: *2013 Joint UFFC, EFTF and PFM Symposium, International Ultrasonics Symposium (IUS), Joint IEEE International Symposium on the Applications of Ferroelectrics (ISAF) and Piezoresponse Force Microscopy and Nanoscale Phenomena*

in Polar Materials (PMF), Joint International Frequency Control Symposium (IFCS), and European Frequency and Time Forum (EFTF), 21-25 July 2013, Prague, Czech Republic IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society International Ultrasonics Symposium (IUS), Joint IEEE International Symposium on the Applications of Ferroelectrics (ISAF) and Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials (PMF), Joint International Frequency Control Symposium (IFCS), and European Frequency and Time Forum (EFTF), 21-25 July 2013, Prague, Czech Republic, [S. l.], IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society, 2013, pp. 310-312.

19. Marko Vrabelj, Hana Uršič, Brigita Rožič, Zdravko Kutnjak, Silvo Drnovšek, Barbara Malič, "Electrocaloric properties of $0.7\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3 - 0.3\text{PbTiO}_3$ ceramics prepared from mechanochemically activated powder", In: *Proceedings, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems*, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 231-234.
20. Janez Zaletelj, Urban Burnik, Jurij F. Tasič, "Registration of satellite images based on road network map", In: *Proceedings of ISPA 2013*, 8th International Symposium on Image and Signal Processing and Analysis, September 4-6, 2013, Trieste, Italy, Giovanni Ramponi, ed., Zagreb, Faculty of Electrical Engineering and Computing, cop. 2013, pp. 49-53.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Jun-ichi Fukuda, Slobodan Žumer, "Cholesteric blue phases under confinement: Skyrmion lattices and other exotic defect structures", In: *Progress in liquid crystal science and technology: in honor of Shunsuke Kobayashi's 80th birthday*, (Series on liquid crystals, vol. 4), Hoi-Sing Kwok, ed., Shohei Naemura, ed., Hiap Liew Ong, ed., New Jersey ... [et al.], World Scientific, cop. 2013, pp. 113-131.
2. Maja Remškar, "Izmerjene ovire na karierni poti raziskovalk v naravoslovju in tehniki", In: *Ženske v znanosti, ženske za znanost: znanstvene perspektive žensk v Sloveniji in dejavniki sprememb*, (Knjižna zbirka Psihologija vsakdanjega življenja), Mirjana Ule, ed., Renata Šribar, ed., Andreja Umek-Venturini, ed., Ljubljana, Fakulteta za družbene vede, Založba FDV, Komisija za ženske v znanosti pri Ministrstvu za izobraževanje, znanost in šport RS, 2013, pp. 77-91.
3. Janez Štrancar, Vanja Kokol, "EPR spectroscopy of biopolymers", In: *Handbook of biopolymer-based materials: from blends and composites to gels and complex networks*, Sabu Thomas, ed., et al, Weinheim, Wiley, cop. 2013, vol. 2, pp. 443-472.
4. Andrej Vilfan, Dušan Babič, Blaž Kavčič, Gašper Kokot, Natan Osterman, Igor Poberaj, Mojca Vilfan, "Measurement of fluid flow generated by artificial cilia", In: *Artificial cilia*, (RSC nanoscience & nanotechnology), Jaap M. J. de Toonder, ed., Patrick R. Onck, ed., Cambridge, The Royal Society of Chemistry, 2013, pp. 244-258.

PATENT APPLICATION

1. Urban Tomc, Andrej Kitanovski, Marko Ožbolt, Uroš Plaznik, Uroš Flisar, Jaka Tušek, Alojz Poredoš, Barbara Malič, Hana Uršič, Silvo Drnovšek, Jena Cilenšek, Zdravko Kutnjak, Brigita Rožič, *Method for electrocaloric energy conversion*, EP13179000.8, European Patent Office, 1.8.2013.

PATENT

1. Janez Pirš, Matej Bažec, Silvija Pirš, Bojan Marin, Bernarda Urankar, Dušan Ponikvar, *Variable contrast, wide viewing angle LCD light-switching filter*, US8542334 (B2), US Patent Office, 24.9.2013.
2. S. G. Psakhie, Volia Isaevich Itin, D. A. Magajeva, O. G. Terehova, E. P. Najden, Olga Vasiljeva, Georgij Mihajlov Andrejevič, Urška Mikac, Boris Turk, *Contrast agent for T1 and/or T2 magnetic resonant scanning and method for preparing it*, RU2471502 (C1), Federal'naja služba po intelektual'n'noj so'stvennosti, 10.1.2013.
3. Maja Remškar, Marko Viršek, Miha Kocmur, Adolf Jesih, *Procedure for synthesis of threadlike tungsten oxide W_5O_{14}* , US8496907 (B2), US Patent Office, 30.7.2013.

MENTORING

1. Franci Bajd, *The influence of blood flow on formation and dissolution of blood clots*: doctoral dissertation, Ljubljana, 2013 (mentor Igor Serša).
2. Matej Cvetko, *Influence of anisotropic nanoparticles on orientational order of liquid crystals*: doctoral dissertation, Maribor, 2013 (mentor Samo Kralj; co-mentor Milan Ambrožič).
3. Venkata Subba R. Jampani, *Chiral nematic colloidal interactions and photonic properties of nematic colloids*: doctoral dissertation, Ljubljana, 2013 (mentor Igor Muševič).
4. Dalija Jesenek, *Phase and structural behavior of effectively two-dimensional liquid crystals*: doctoral dissertation, Ljubljana, 2013 (mentor Samo Kralj).
5. Janez Kogovšek, *Tribological effects of nanoparticles in lubricants*: doctoral dissertation, Ljubljana, 2013 (mentor Mitjan Kalin; co-mentor Maja Remškar).
6. Gašper Kokot, *Measuring forces with magneto-optical tweezers in biological and biomimetic systems*: doctoral dissertation, Ljubljana, 2013 (mentor Andrej Vilfan).
7. David Lukman, *Gripper for objects in micro- and nano-scale*: doctoral dissertation, Maribor, 2013 (mentor Riko Šafarič; co-mentor Maja Remškar).
8. Nikola Novak, *Study of polar ordering in ordered and partial disordered ferroelectric systems*: doctoral dissertation, Ljubljana, 2013 (mentor Zdravko Kutnjak).
9. Tine Porenta, *Flexo-electric and optic field effects on confined chiral and achiral nematic ordering*: doctoral dissertation, Ljubljana, 2013 (mentor Slobodan Žumer).
10. Anton Potočnik, *Magnetic resonance of molecular superconductors bordering the antiferromagnetic Mott-insulating state*: doctoral dissertation, Ljubljana, 2013 (mentor Denis Arčon).
11. Iztok Urbančič, *Response of biomembrane domains to external stimuli*: doctoral dissertation, Maribor, 2013 (mentor Janez Štrancar; co-mentor Miha Škarabot).
12. Bojana Višič, *Physical properties of nanoflakes produced by exfoliation of MoS_2 nanotubes and their respective polymer nanocomposites*: doctoral dissertation, Ljubljana, 2013 (mentor Maja Remškar).
13. Miha Čančula, *Modeling of light propagation along nematic defect lines*: master's thesis, Ljubljana, 2013 (mentor Slobodan Žumer; co-mentor Miha Ravnik).
14. Urška Gradišar, *Thermoluminescence analysis of irradiated food*: master's thesis, Ljubljana, 2013 (mentor Žiga Šmit; co-mentors Benjamin Zorko, Katarina Vogel-Mikuš and Marijan Nečemer).
15. Luka Mesarec, *Topological defects in nematic shells*: master's thesis, Maribor, 2013 (mentor Samo Kralj; co-mentor Aleš Igljič).

DEPARTMENT FOR COMPLEX MATTER

F-7

The research within the Department of Complex Matter encompasses a variety of research fields, ranging from the synthesis of new materials to fundamental investigations of elementary excitations in complex systems. These include anything from nano-biosystems to magnetic systems and superconductors. The experimental methods used are suitably diverse, from synthetic chemistry to femtosecond laser spectroscopy. Last year's research achievements are thus quite diverse, but we are able to report on breakthroughs in a number of areas.



Head:
Prof. Dragan D. Mihailović

The activities in the department can be grouped together into a number of thematically inter-related research areas. Nanomaterials science research is focused on investigations into the fundamental properties and applications of MoSI molecular wires, crossing into the physics and nanoscience of macromolecular biological systems such as DNA and cilia, and venturing into quantum molecular electronics and nano-electronics. These and other materials, such as strongly correlated systems, electronically ordered systems and superconductors were investigated using advanced femtosecond spectroscopy techniques. In many areas we have introduced new materials, technologies and techniques.

In 2013 we spent a lot of effort on setting up new mid- and long-term research projects, which was started in the past two years. In particular, new techniques were developed for the study of non-equilibrium phase transitions, involving both theoretical and experimental work. This already paid dividends in the form of a number of breakthrough publications published in 2013, or to appear early in 2014. Most notable of the already published works is the publication in *Nature* on the discovery of a ferromagnetic liquid crystal composite by Alenka Mertelj et al., described in more detail below. Similarly, our pioneering forays into sample preparation yielded results with the publication of a paper by Jure Strle and co-workers in *Nature Materials* on molecular-beam-epitaxy-grown thin films. Notable publications in 2013 include the first observation of intrinsic and extrinsic topological defect dynamics in *Physical Review Letters* by T. Mertelj et al. Other notable publications on various subjects are listed below.

A significant amount of work was devoted to setting up new equipment made available by the Centre of Excellence in Nanoscience and Nanotechnology – Nanocenter. The department thus acquired a new AFM/Micro-Raman system with low-temperature vacuum capability, and a significant share and leading role in the running of a FIB dual-beam microscope, both of which are currently fully operational. In addition, in 2013 we continued the development of a new, low-temperature, four-probe STM/AFM system with Omicron, which is a unique instrument enabling unprecedented 4-contact measurements of surface transport on the nanoscale. A prototype version was installed in November of 2013 and a final version will be delivered early in 2014. An atomic layer deposition system was set up and tested, and is giving excellent results with the successful demonstration of a MoS₂ nanotube field-effect transistor with comparable performance to the revolutionary MoS₂ single-layer transistors reported by Kis et al. in 2010 from EPFL.

Ultrafast studies of electron dynamics in correlated systems

The field of research of relaxation processes of photo-excited electrons in correlated electron systems is one of our most advanced research topics. One part of this research includes the development of new methods, instrumentation and ultrafast laser systems for spectroscopy. New femtosecond techniques are thus being developed, such as multipulse spectroscopy and broad-band optical probe spectroscopy.

The research encompasses many different areas of physics and materials science. The most advanced part of the research takes place in conjunction with an ERC Advanced Grant on “Coherent trajectories through symmetry breaking transitions” which started in the first part of 2103. This work is challenging both conceptually and practically, and is still at an embryonic stage. Much of this work is thus still in the exploratory stage and not considered for publication as yet. The general framework is within the scope of “Cosmology in the lab experiments”, coming from the analogy with the Big bang in cosmology or collisions in elementary particle physics in which phase transitions also take place in time from a highly excited plasma, much in the same way as phase transitions take place after the excitation of collectively

Several experimental studies of carrier relaxation phenomena in correlated electron systems with various degrees of correlation have been performed using femtosecond time-resolved techniques. The aim of the ongoing research is to gain additional information about the nature of the low-lying excitations in these materials, and to explore the nature and strength of the interactions of electrons with other low-lying excitations.

ordered states in electronic systems which we investigate here. One of the novelties in these investigations relates to the study of non-equilibrium transitions in which the single particle and collective excitations are not in thermal equilibrium with each other and cannot be described in terms of a common temperature. Under such non-ergodic conditions the system trajectory is expected to be different than under ergodic conditions, and represent an absolute novelty, opening the way to unexplored new physics.

At the other end of the spectrum, femtosecond laser spectroscopy has developed over the years from an exotic experimental technique to a mainstream characterisation tool in materials science. The technique is now used to characterise the band structure of different materials, offering some unique insights that are not available with other spectroscopy techniques. For example, different excitations can be distinguished by their different lifetimes, thus allowing pseudogap excitations to be distinguished from a spin or superconducting gap.

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We continued our research of the relaxation of quasiparticles in iron-based pnictide superconductors. We systematically investigate the photo-excited (PE) quasi-particle (QP) relaxation and low-energy electronic structure in an electron-doped, 1111-structure $\text{Sm}(\text{Fe}_{0.93}\text{Co}_{0.07})\text{AsO}$ single crystal. We found that the behaviour is qualitatively identical to the 122-structure $\text{Ba}(\text{Fe},\text{Co})_2\text{As}_2$ including the presence of a normal state pseudogap and a marked twofold symmetry breaking in the tetragonal phase that we relate to the electronic nematicity. The twofold symmetry breaking appears to be a general feature of the electron-doped iron pnictides. The results were published in *Phys. Rev. B* 87, 174525 (2013).

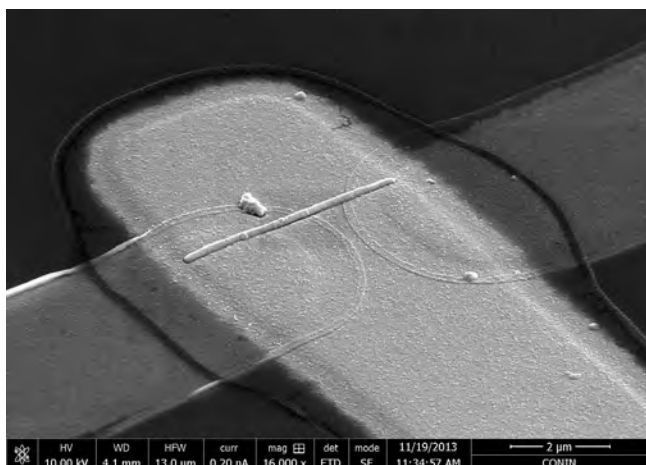


Figure 1: FET transistor, based on MoS2 nanotubes.

We continued the analysis of previously measured temperature and magnetic-field-dependent photo-excited electron and spin relaxation in $\text{EuFe}_2(\text{As}_{0.7}\text{P}_{0.3})_2$ (EFAP) pnictide superconductor and parent non-superconducting EuFe_2As_2 (EFA) by means of near-infrared optical pump-probe femtosecond spectroscopy. In both samples we observe at low temperature the emergence of a slow anisotropic photo-induced relaxation component concurrent with Eu^{2+} spin ordering. The slow dynamics of this component suggests a weak coupling between the Eu^{2+} spins and the carriers in the Fe-d derived bands.

The magnetic field dependence of the relaxation in the superconducting EFAP is different than in the non-superconducting EFA. In EFA we observe switching of the optical-transients anisotropy with an increasing magnetic field attributed to a field-induced antiferromagnetic-to-ferromagnetic phase transition. In the superconducting EFAP a large coherent magnon oscillation is observed at a similar metamagnetic transition. A short paper on some of the above results is in print in *Optics and Spectroscopy*, while a manuscript describing the majority of the results is in preparation.

A remarkable change of the quasiparticle relaxation dynamics at the antiferromagnetic SDW transition temperature in EFA and related BaFe_2As_2 and SrFe_2As_2 , observed previously by the near-infrared probe, was systematically investigated by broad-band visible time-resolved spectroscopy. Two different relaxation processes were identified. The behaviour of the slower process, which is strongly sensitive to the magneto-structural transition, is consistent with the relaxation-bottleneck model involving magnons. Manuscripts describing the results are in the final stage of preparation.

In collaboration with Hokkaido University, Sapporo, Japan we investigated the dynamics of excitations with different symmetry in the superconducting (SC) and normal state of the high-temperature superconductor $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+d}$ ($\text{Bi}2212$) using optical pump-probe (Pp) experiments with different light polarizations at different doping levels. The observation of distinct selection rules for SC excitations, present in A1g and B1g symmetries, and for the pseudogap excitations, present in A1g and B2g symmetries, by the probe and absence of any dependence on the pump beam polarization leads to the unequivocal conclusion of the existence of a spontaneous spatial symmetry breaking in the pseudogap state. A manuscript describing the work was submitted to *Phys. Rev. Lett.* and is in the reviewing process.

A significant effort was invested into an investigation of the dynamical phase transitions in superconducting and CDW systems. The control of condensed-matter systems out of equilibrium by laser pulses allows us to

The observation of distinct selection rules for SC excitations, present in A1g and B1g symmetries, and for the pseudogap excitations, present in A1g and B2g symmetries, by the probe and absence of any dependence on the pump beam polarization leads to the unequivocal conclusion of the existence of a spontaneous spatial symmetry breaking in the pseudogap state.

investigate the system trajectories through symmetry-breaking phase transitions. Thus the evolution of both collective modes and single-particle excitations can be followed through diverse phase transitions with femtosecond resolution. We presented experimental observations of the order parameter trajectory in the normal \rightarrow superconductor transition and charge-density wave-ordering transitions. Of particular interest is the coherent evolution of topological defects forming during the transition via the Kibble–Zurek mechanism, which appears to be measurable in optical pump–probe experiments. Experiments on CDW systems reveal some new phenomena, such as coherent oscillations of the order parameter, the creation and emission of dispersive amplitude modes upon the annihilation of topological defects, and mixing with weakly coupled finite frequency (massive) bosons as described in *J. Phys.: Condens. Matter* 25, 404206 (2013). The paper was written at the invitation of Tom Kibble, and the entire journal issue was devoted to Cosmology in the laboratory experiments in his honour. The paper also reveals some new ideas concerning dark-matter excitations within the phase-transition picture and discusses the observation of the annihilation of domain walls and the ensuing emission of Higgs bosons detected in femtosecond optical experiments.

We extended previous investigations of $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+d}$ cuprate superconductors by means of the 3-pulse time-resolved optical spectroscopy technique to different doping levels. The characteristic footprint of the superconducting response was also detected at temperatures above T_c , indicating the presence of the superconducting fluctuations up to 23 K above T_c , and are distinct from the excitations in the pseudogap state, which are observable up to $T = 200\text{--}250$ K. We empirically establish the direct correspondence between the bare superfluid density as measured by the THz spectroscopy and the optical pump-probe response near T_c . The lifetime of both, the order parameter recovery associated with the superconducting fluctuations and quasiparticle recombination, is observed to diverge as T goes to T_c . The critical behaviour of the lifetime significantly differs from the time-dependent Ginzburg-Landau theory prediction for Gaussian fluctuations and phase correlation time measured by a.c. conductivity. The manuscript with the results is in the final stage of preparation.

In CDW systems we studied the incoherent recombination of topological defects created during a rapid quench of a charge-density-wave system through the electronic ordering transition. Using the above mentioned 3-pulse femtosecond optical spectroscopy technique we follow the evolution of the order parameter over a wide range of timescales after the quench. By careful consideration of thermal processes we clearly identified the intrinsic topological defect annihilation processes in TbTe_3 on a timescale of ~ 30 ps and found the signature of extrinsic defect-dominated relaxation dynamics occurring on longer timescales. A similar effect was also observed in blue bronze and 2H-TaSe_2 . The results were published in *Phys. Rev. Lett.* 110, 156401 (2013).

The achievement of optical bistable switching between collective states of matter by non-thermal processes has great potential applications, but has so far been very elusive. Commonly, the photo-excited states are transient, and do not show true switching behaviour. After we have shown for the first time complete switching in 1T-TaS_2 between the ground state and a new stable hidden state by a single laser pulse, we continued the investigation of the stability and transport properties of the switched state in thin 1T-TaS_2 flakes adhered to various substrates by Van der Waals forces. A manuscript describing the major results is currently in the review process at Science

A prerequisite to perform femtosecond electron diffraction on modern quantum materials such as 1T-TaS_2 is the availability of laterally large ($\sim 100\ \mu\text{m}$) and sufficiently thin (< 100 nm) single-crystalline samples. Different approaches to reach these specifications have been tried out and their effect on sample integrity has been investigated. Finally, using an ultra-microtome, we were able to prepare 30 nm free-standing single-crystalline films of 1T-TaS_2 with lateral dimensions of $200\ \mu\text{m} \times 200\ \mu\text{m}$. We have characterized these films with different techniques for their stoichiometric and crystalline integrity, ensuring no measurable alternation of the sample properties. The application of this sample-thinning technique is expected to find its use in further structural dynamics studies, as well as in optical time-resolved studies where homogeneous excitation profile and/or data in transmission geometry may be required. as reported in *Ultramicroscopy* 127, 9 (2013)

A table-top, femtosecond, non-relativistic, electron-diffraction setup is combined with a low-jitter, photo-triggered streak camera to follow the optically induced structural dynamics in complex solids. A temporal resolution of 550 fs is experimentally demonstrated, while the route to streaking with sub-250 fs temporal resolution is outlined. The technique is demonstrated by studying a photo-induced charge-density wave phase transition in 4Hb-TaSe_2 . Within the same data-acquisition time a three-fold increase in the signal-to-noise ratio is achieved when compared to the scanning method, with ways for a further improvement outlined. *Appl. Phys. Lett.* 102, 121106 (2013)

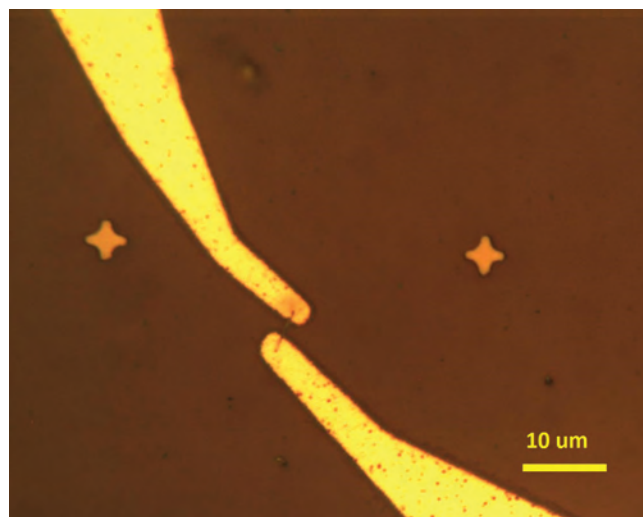


Figure 2: Golden electrodes on the nanowire, made with the laser lithography technique.

Theoretical studies on the nanoscale

We study theoretically how the dynamics of the resistive state in narrow superconducting channels shunted by an external resistor depends on the channel's length, the applied current, and parameter u characterizing the penetration depth of the electric field in non-equilibrium superconductors. We show that changing u dramatically affects both the behavior of the current-voltage characteristics of the superconducting channels and the dynamics

of their order parameter. Depending on the value of the parameter u the current-voltage characteristic may be step like or hysteretic. Shunting the superconductor with the resistor leads to the disappearance of the hysteretic current-voltage characteristic. (Physical Review B 87, 174516 (2013)).

We present a detailed analysis of the time-resolved optical data on blue bronzes ($K_{0.3}MoO_3$ and $Rb_{0.3}MoO_3$), prototype quasi-one-dimensional charge-density wave systems. Numerous coherent (Raman active) modes appear upon the phase transition into the CDW state. We analyze the temperature dependence of the mode frequencies, their damping times, as well as their oscillator strengths and phases using the time-dependent Ginzburg-Landau model. We demonstrate that these low-temperature modes are a result of the linear coupling between the Fermi surface nesting driven modulation of the conduction electron density and the normal-state phonons at the CDW wave vector, and determine their coupling strengths. We were able to identify the nature of the excitation of these coupled modes, as well as the nature of the probing mechanisms in this type of experiments. We demonstrate that in incommensurate CDW systems, femtosecond optical excitation initially suppresses the electronic density modulation, while the reflectivity changes at frequencies far above the CDW-induced gap in the single-particle excitation spectrum are governed by the modulation of interband transitions caused by lattice motion. (Physical Review B 89, 045106 (2014)).

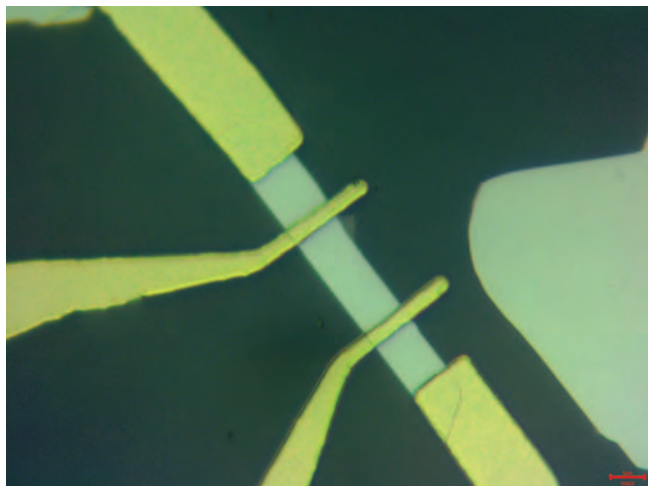


Figure 3: Micrometer contacts on a sample of TaS_2 made with the laser lithography technique.

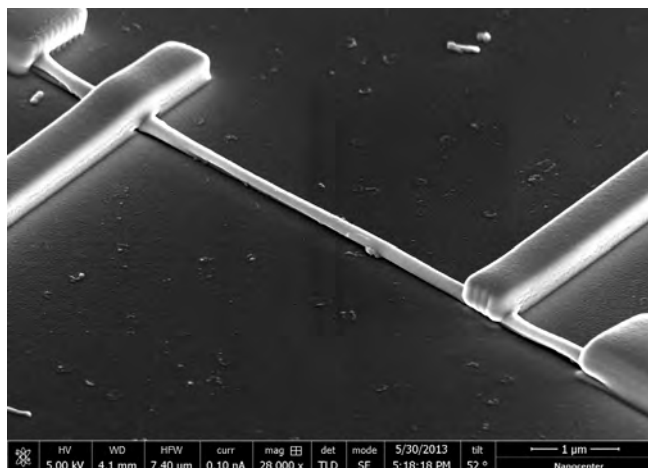


Figure 4: MoN nanowire with four Pt measuring contacts, which are prepared using FIB-assisted deposition.

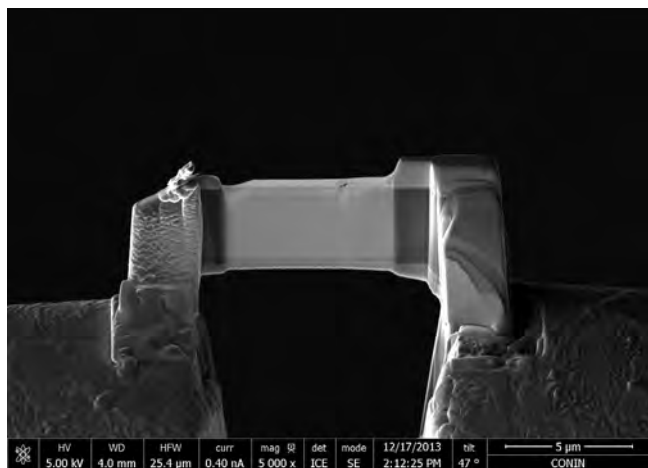


Figure 5: FIB-fabricated TEM lamella. Thickness is in the range of 60–80nm.

Nanomaterials

Nanowires and nanotubes decorated with gold nanoparticles are known for their excellent sensing and catalytic properties. However, the decoration of transition-metal dichalcogenide nanotubes can be very complex. We have found a simple procedure that enables the efficient production and purification of thin bundles of MoSi nanowires decorated with gold nanoparticles and their transformation to gold-decorated MoS_2 nanotubes. We isolated several hundred milligrams of nanowire bundles that were several microns long with average diameters of around 40 nm, and formed a stable dispersion in water without added surfactants. Gold nanoparticles were directly deposited on the nanowire bundles, either in a solution or on a substrate at room temperature in a single-step reaction without any additional reducing reagents. The described procedure is one of the few examples of redox templating at room temperature without the use of a reducing agent to produce metal-decorated nanowires. The number of gold nanoparticles on a nanowire bundle is controlled by changing the concentration of chloroauric acid $HAuCl_4$ in the solution. Since the nanowires can serve as precursor crystals for the fabrication of nanotubes, we were able to transform gold-decorated nanowires and produce gold-decorated MoS_2 nanotubes. These results are reported in J Nanopart Res (2013) 15:1791

Electron dynamics in biological macromolecules

In 2013 we concluded our experimental work on dc electron transport in DNA and its complex with transition-metal cations – M-DNA. Transport measurements were performed on micron-sized electric circuits produced by e-beam lithography with parallel gold electrodes. The electrodes were separated by a several hundred nanometers wide gap (typically 250–500 nm). The gap was bridged with individual DNA molecules that were cast from a buffer solution onto the silicone chip surface. Such single molecule electric nanocircuits have enabled us to measure the I-V characteristics of

individual DNA/M-DNA molecules under ambient conditions as well as the temperature dependences of their electrical conductivity in a broad temperature range (20–300 K). The measurements have shown that the conductivity of a pristine DNA exhibits an activated behavior where the conductivity exponentially decays towards zero as the temperature is lowered from room temperature – a behavior typical for electric insulators. In contrast, the conductivity of an M-DNA molecule has shown a plateau in the middle temperature range (100–200 K) where the conductivity is virtually temperature-independent. These results give a firm support to a hypothesis that the electron transport in M-DNA is strongly correlated and much more efficient at longer (> 10 nm) distances than in the native DNA.

Thin-film synthesis and characterization

In 2013 we gained access to new thin-film synthesis techniques – Molecular Beam Epitaxy (MBE) and Atomic Layer Deposition (ALD).

One of the intensely studied scenarios of high-temperature superconductivity (HTS) postulates pairing by the exchange of magnetic excitations. In the heavily overdoped regime, neutron scattering measurements indicate that magnetic excitations have effectively disappeared, and this has been argued to cause the demise of HTS with overdoping. We have used resonant inelastic X-ray scattering to measure the evolution of magnetic excitations in $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ across the entire phase diagram, from a strongly correlated insulator to a non-superconducting metal ($0 \leq x \leq 0.40$). For $x = 0$, well-defined magnon excitations were observed. These magnons broaden with doping, but they persist with a similar dispersion and comparable intensity all the way to the non-superconducting, heavily overdoped metallic phase. We have concluded that the destruction of HTS by overdoping is caused neither by the general disappearance nor by the overall softening of magnetic excitations. These results were produced in collaboration with Brookhaven National Laboratory where we have performed sample characterization, and were reported in *Nature Materials* 12, 1019-1023 (2013).

Soft Matter

Also in 2013 we continued with investigations of optical holographic patterning in light-sensitive liquid-crystal elastomers (LCEs). These are polymer materials that exhibit a very strong opto-mechanical response, due to which they are promising for applications in various optically manipulated micromechanical devices. We performed a comparative study of UV-irradiation-induced refractive-index modulation in two analogous monodomain nematic side-chain LCE materials. In one of them mesogenic azobenzene derivatives were incorporated as pendant comonomers, and in the other as crosslinking units. The results are reported in the paper *Macromol. Chem. Phys.* 214, p. 2744 (2013). We also completed the investigation of optical-patterning properties in the vicinity of nematic-paranematic phase transition and reported our results in *Phys. Rev. E*, 87, p. 022507 (2013).

We completed our investigation of the effect of inorganic nanotubes and nanowires on the electro-optical properties of standard nematic liquid crystals. The results are reported in the paper *Phys. Status Solidi. A* 210, p. 2328 (2013). We also studied the inclusion of MoS_2 nanotubes into polymerizable nematic liquid crystal material RM257 (Merck) and successfully fabricated a polymer-nanotube composite material with strongly aligned nanotubes.

In cooperation with TEDA APS at Nankai University (China) we investigated surface structure modifications of silicon induced by irradiation with a single femtosecond laser pulse and the possible application of the resulting surface structures for surface-enhanced Raman scattering. The results were reported in *J. Raman Spectrosc.* 44, p. 1678 (2013) and *Optics Letters* 39, p. 343 (2014). Another topic of our cooperation was the investigation of intracellular processes in biological cells. We investigated correlations of the fluctuations of calcium ion concentration between different cells and temperature-induced modifications of radiative activity of fluoropores sensitive to calcium ions. The results were published in *Biochem. Biophys. Res. Commun.* 431, p. 664 (2013) and *Biochem. Biophys. Res. Commun.*, in-press, (2014).

In cooperation with the Center of Excellence for Polymer Materials and Technologies (PoliMaT) we performed a systematic analysis of the effect of oxygen plasma on the water-sorption properties of cellulose fibers. We demonstrated that modifications of optical birefringence of the fibers can be conveniently used to monitor the kinetics of the sorption process. The results were reported in *Carbohydrate Polymers* 97, p. 143 (2013).

A newly started cooperation with Seoul National University (Korea) was focused on investigations of the optical properties of closed-packed arrays of cholesteric liquid-crystal droplets. We discovered that the color-selective optical reflection of the droplets provides several interesting possibilities for interdroplet communication processes. This collaborative work was reported in *J. Mater. Chem. C* 2, p. 806 (2014).

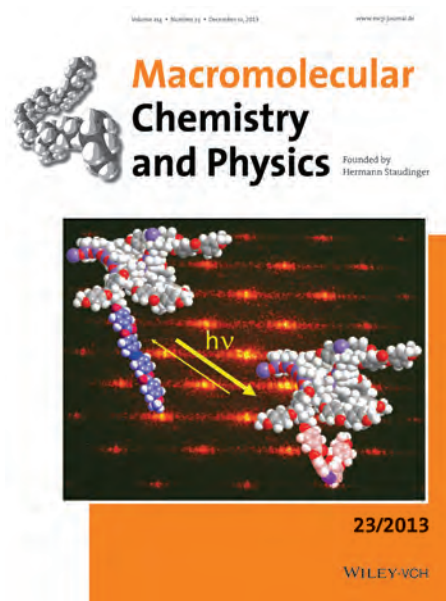


Figure 6: The cover of the magazine *Macromolecular Chemistry and Physics*. Author of the picture: Irena Drevenšek Olenik

We completed a comparative study of the aggregation properties of four similar guanine (G)-rich DNA oligonucleotides.

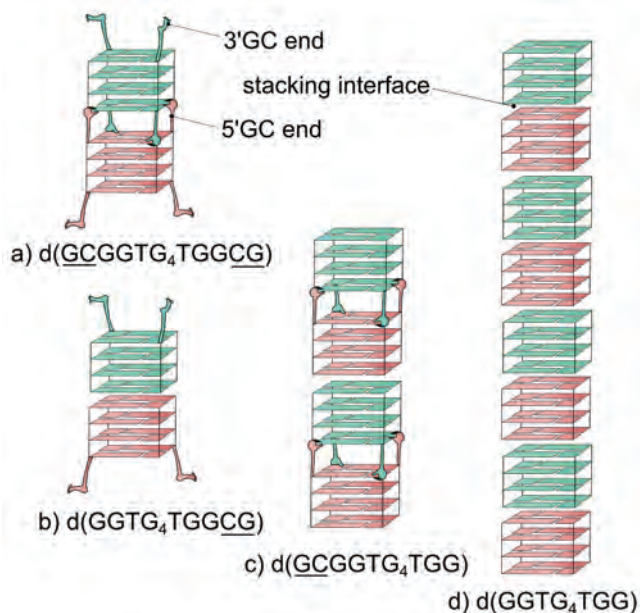


Figure 7: The growth-mechanism of guanine-based nanowires (G-wires) is preferably G-quartet stacking while GC-base pairing proved to be highly limited.

We showed that in an ordered nematic liquid-crystalline phase of the suspension of BaHF nanoplatelets doped with Sc in liquid-crystal 5CB ferromagnetic ordering appears.

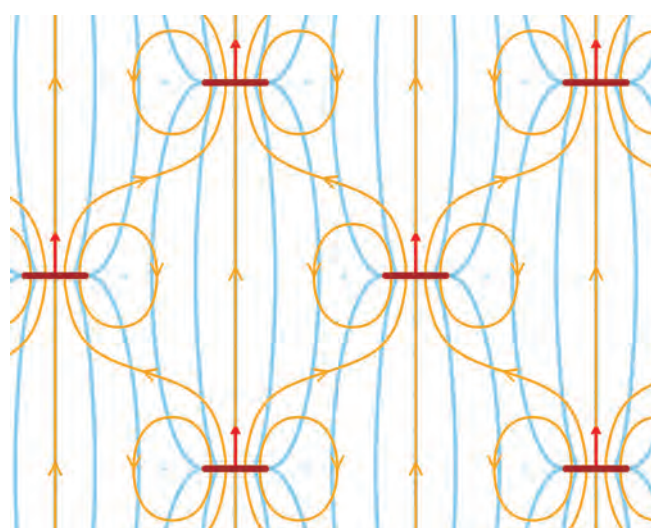


Figure 8: A schematic presentation of the distortion of the director (blue) and magnetic field (orange) around disk-like platelets (short, thick horizontal lines) represented side-on. Blue dots indicate cross-sections of disclination lines, and red arrows the directions of magnetic moments.

We completed a comparative study of the aggregation properties of four similar guanine (G)-rich DNA oligonucleotides in a collaboration with the National Institute of Chemistry, Ljubljana and the University of Ulster, UK. The results show that all the investigated oligonucleotides assemble into G-quadruplex structures. But, in contrast to the expected behaviour, oligonucleotides without the “sticky” GC ends form shorter G4-wire structures than the oligonucleotides without the GC ends. The results were reported in *J. Phys. Chem. C* 117, p. 23208 (2013). Our research work on G-quadruplex related molecular self-assembly was also published in two chapters in the monographic publication: “*Guanine quartets: structure and application*”, edited by W. Fritzsche and L. Spindler (RSC Publishing, Cambridge, UK, 2013).

We showed that in the ordered nematic liquid-crystalline phase of the suspension of BaHF nanoplatelets doped with Sc in liquid-crystal 5CB ferromagnetic ordering appears. The magnetization is along the nematic director and comes from the ferromagnetic ordering of the nanoplatelets. When the sample is prepared in the absence of an external magnetic field, two types of magnetic domains appear with magnetizations in the opposite directions. If during the preparation an external magnetic field along the director is applied, a monodomain sample is obtained. Magnetization curves show that a small magnetic field is needed to switch the domains. In samples with a low concentration of magnetic platelets the memory of the initial magnetic state of the sample is preserved and after the removal of the external field, the sample relaxes back to its initial magnetic state, while in samples with a high enough concentration a complete reversal of magnetization can be observed. During this complete reversal the travelling of the domain walls at the sample surface can be observed. The results are reported in *Nature* 504, 237–241 (2013).

Nonlinear optics

In the Nonlinear Optics Laboratory we study new materials and their interaction with laser light. Integrated optics is a promising technology; however, better materials will increase its potential. In cooperation with North Carolina State University in Raleigh, USA, we study new concepts of compact light sources on the basis of the nonlinear optical conversion of existing lasers into the spectral regions where lasers are not yet available. AlGaIn grown by metal-organic chemical vapor deposition (MOCVD) has a great potential for optoelectronic devices emitting and detecting light in the ultraviolet (UV) wavelength regime. We study AlGaIn waveguides with an alternating sign of the nonlinear coefficient in regular intervals and allows quasi phase matching.

The terahertz spectrum offers a broad range of applications in the chemical sensing and non-destructive testing of materials impenetrable by infrared or visible light. Broadband THz pulses may be generated by using femtosecond laser pulses combined with photoconductive switches and semiconductor surfaces, as well as by optical rectification in nonlinear optical crystals. The total THz power generated with these techniques is distributed over a broader spectral range. To obtain reasonable power at a certain THz frequency, a narrower band pulsed output with a high beam peak power is preferred. In cooperation with Rainbow Photonics A.G., a spin-off company of ETH Zurich, we study THz generation with difference frequency mixing. We developed a compact two-frequency laser where the two frequencies are generated in Nd:YAG and Yb:YAG branches of a split laser resonator with a common Q-switch and an output coupler. The emission wavelengths at 1.03 μm and 1.06 μm are mixed in a stack of thin platelets of organic crystal OH1 using quasi-phase matching. The generated THz frequency of 9.3 THz

is sufficiently far away from the water absorption lines and therefore large propagation distances of the THz waves can be realized in devices, e.g., for remote materials testing.

Biomedical optics

We have investigated the potential of non-contact measurements of laser-induced temperature profiles in biological tissues based on pulsed photo-thermal radiometry (PPTR). Using a laboratory PPTR setup, we have monitored the laser removal of tattoos in human volunteers. We have demonstrated the relevance of the obtained information for studies of the interaction process and guidance of therapy on an individual patient basis.

Using the same technique, we have characterized the interaction of a prototype Nd:YAP laser (1342 nm) with the skin of healthy volunteers, and compared it with two common medical lasers (Nd:YAG and KTP, emitting at 1064 and 532 nm, respectively). The results indicate that the Nd:YAP laser is very suitable for non-ablative rejuvenation of sun-damaged skin. Both studies were performed in collaboration with Fotona d.d., Ljubljana.

By combining the above experimental approach and a dedicated numerical model, we have developed an original method for the individual determination of the maximum safe radiant exposure in the irradiation of human skin with millisecond laser pulses. Our approach has great potential for improving the efficacy and safety of several dermatologic laser treatments. We have analyzed the influence of the acquisition sampling rate and noise characteristics of the infrared radiation detector on the procedure.

A similar approach was also adopted for a quantitative assessment of hemoglobin mass diffusion, physiological degradation rate, and depth of blood spill in traumatic bruises (hematomas). The obtained knowledge should enable the development of more accurate and reliable techniques for a determination of the time of injury in forensic science.

We have developed a three-dimensional (3D) Monte Carlo (MC) model of light transport in strongly scattering and heterogeneous human skin with a rigorous treatment of analytically defined boundaries between neighbouring tissues. In contrast with the common implementation of the 3D MC approach, where tissue boundaries are approximated according to the rectangular spatial grid, the results of our model do not depend on the positioning or discretization step of the spatial grid.

We have studied the potential of diffuse reflectance spectroscopy (DRS) for the non-contact characterization of biological tissues. We have developed an original approach for the rigorous elimination of a known artefact in measurements of DRS using an integrating sphere. We have analyzed the accuracy and robustness of DRS analysis using analytical solutions for the transport of light in strongly scattering tissues, derived within the so-called diffusion approximation. (Collaboration with NTNU, Trondheim, Norway).

Biological systems

We studied biomimetic systems, especially artificial cilia and artificial swimmers at low Reynolds numbers. The unique magneto-optical tweezers, which were used in the experiment, were developed at the Laboratory for Experimental Soft Matter, Faculty of Mathematics and Physics, University of Ljubljana. The fabrication of artificial cilia, the characterisation of generated fluid flows, the coupling between cilia and the fabrication of colloidal scaffold for cell growth were also the topics included in the thesis by young researcher Gasper Kokot, who successfully defended his thesis "Measuring forces with magneto-optical tweezers in biological and biomimetic systems". Our work on artificial cilia also appeared in the book *Artificial Cilia*, published by the Royal Society of Chemistry, Cambridge, UK.

Biomimetic research also included systems of artificial swimmers. We studied different mechanisms that led to processive motion. The symmetry in the system was broken with the vicinity of the surface and different hydrodynamic drag on the individual components of the swimmer. We created isotropic swimmers that move in an arbitrary direction, not determined by the driving external magnetic field. Microswimmers achieved a velocity of several micrometers per second under optimal conditions. The experimental part of the research is completed, and in collaboration with the Department for Condensed Matter Physics (F5), numerical simulations are being done to explain the observed phenomena. Experimental work was presented at the International Soft Matter Conference in Rome and a paper is in preparation.

In collaboration with the Department for Condensed Matter Physics (F5) we also numerically investigated the energy efficiency of different beating patterns of artificial cilia. We have shown the importance of metachronal coordination for the generation of fluid flow above a densely ciliated surface

Non-invasive measurements of temperature profiles induced in healthy human skin with a prototype Nd:YAP laser have demonstrated the suitability of its 1342-nm emission for non-ablative skin rejuvenation. (collaboration with Fotona d.d., Ljubljana)

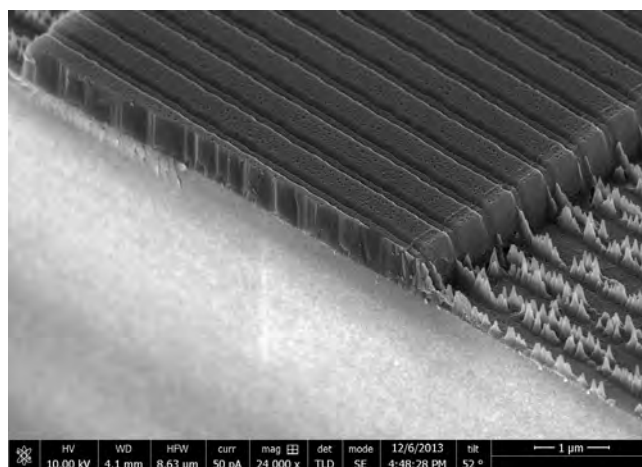


Figure 9: Periodically inverted domains of Al-polar and N-polar AlN forming an optical waveguide. Such a structure is used for nonlinear frequency conversion by quasi phase matching into the deep UV region.

and that even time-symmetric reciprocal motion enables pumping. The results were presented at two international conferences: Biophysical Society Meeting, Philadelphia, USA and at Dynein 2013 in Kobe, Japan.

We also continued our work on thermophoresis, which is carried out in collaboration with the group of Professor Braun, University of Munich, Germany. Thermal gradients were used to successfully move molecules of DNA and we have shown that the replication and accumulation of DNA can be implemented in the same micrometer-sized setting. This opens up a new approach to understanding the dynamic development of a molecular Darwinian system. The results of the investigations were published in the paper "Could Thermal Gradient Drive Molecular Evolution?", *Curr. Org. Chem.* 17 1732 (2013).

Some outstanding publications in the past year

1. Mertelj, A., Lisjak, D., Drofenik, M., Čopič, M.: Ferromagnetism in suspensions of magnetic platelets in liquid crystal. *Nature*, 2013, vol. 504, no. 7479, 237–241
2. Mertelj, T., Kušar, P., Kabanov, V. V., Giraldo-Gallo, P., Fisher, I. R., Mihailović, D.: Incoherent topological defect recombination dynamics in $t\text{bte}_3$; T. Mertelj] ... [et al.]. *Physical review letters* [print ed.], 2013, vol. 110, no. 15, 156401-1-156401-5
3. Mertelj, T., Stojchevska, L., Karpinski, J., Mihailović, D.: Normal state bottleneck and nematic fluctuations from femtosecond quasiparticle relaxation dynamics in $\text{sm}(\text{fe},\text{co})\text{aso}$. *Physical review. B, Condensed matter and materials physics*, 2013, vol. 87, no. 17, 174525-1-174525-6
4. Dean, M. P. M., Strle, J., et al.: Persistence of magnetic excitations in $\text{La}_{(2-x)}\text{Sr}_x\text{CuO}_4$ from the undoped insulator to the heavily overdoped non-superconducting metal. *Nature materials*, 2013, vol. 12, issue 11, 1019–1023
5. Gregorc, M., Li, H., Domenici, V., Ambrožič, G., Čopič, M., Drevenšek Olenik, I.: Optical properties of light-sensitive liquid-crystal elastomers in the vicinity of the nematic-paranematic phase transition. *Physical review. E, Statistical, nonlinear, and soft matter physics*, 2013, vol. 87, iss. 2, 022507-1-022507-7
6. Rigler, M., Zgonik, M., Hoffmann, M. P., Kirste, R., Bobea, M., Collazo, R., Sitar, Z., Mita, S., Gerhold, M.: Refractive index of III-metal-polar and N-polar AlGaIn waveguides grown by metal organic chemical vapor deposition. *Applied physics letters*, 2013, vol. 102, 221106-1-221106-5
7. Ilc, T., Šket, P., Plavec, J., Webba Da Silva, M., Drevenšek Olenik, I., Spindler, L.: Formation of G-wires : the role of G:C-base pairing and G-quartet stacking. *The journal of physical chemistry. C, Nanomaterials and interfaces*, 2013, vol. 117, iss. 44, 3208-23215
8. Milanič, M., Majaron, B.: Energy deposition profile in human skin upon irradiation with a 1,342 nm nd:yap laser. *Lasers in surgery and medicine*, 2013, vol. 45, no. 1, 8–14

Some outstanding publications in 2012

1. Čoga, L., Ilc, T., Devetak, M., Masiero, S., Gramigna, L., Spada, G. P., Drevenšek Olenik, I.: Liponucleoside thin films: the special behaviour of guanosine. *Colloids surf., B Biointerfaces*. [print Ed.], 2012, vol. 103, 45–51
2. Jia, W., Tran, N., Sun, V., Marinček, M., Majaron, B., Choi, B., Nelson, J. S.: Photocoagulation of dermal blood vessels with multiple laser pulses in an in vivo microvascular model. *Lasers surg. med.*, 2012, vol. 44, no. 2, 144–151
3. Kušar, P., Gruber, C., Hohenau, A., Krenn, J. R.: Measurement and reduction of damping in plasmonic nanowires. *Nano lett. (print)*, 2012, vol. 12, no. 2, 661–665
4. Alexandrov, A. S., Dediu, V. A., Kabanov, V. V.: Hopping magnetotransport via nonzero orbital momentum states and organic magnetoresistance. *Phys. Rev. Lett.*, 2012, vol. 108, no. 18, 186601-1-186601-5
5. Stojchevska, L., Mertelj, T., Fisher, I. R., Mihailović, D.: Doping dependence of femtosecond quasiparticle relaxation dynamics in $\text{Ba}(\text{fe},\text{co})_2\text{as}_2$ single crystals: evidence for normal-state nematic fluctuations. *Phys. Rev., B, Condens. matter mater. phys.*, 2012, vol. 86, no. 2, 024519-1-024519-12
6. Mertelj, A., Cmok, L., Čopič, M., Cook, G., Evans, D. R.: Critical behavior of director fluctuations in suspensions of ferroelectric nanoparticles in liquid crystals at the nematic to smectic-A phase transition. *Phys. rev., E Stat. nonlinear soft matter phys. (print)*, 2012, vol. 85, no. 2, 021705-1-021705-7
7. Mast, C. B., Osterman, N., Braun, D.: Thermal solution for molecular evolution. *Int. j. mod. phys. B*, 2012, vol. 26, no. 32, 1230017-1-1230017-13

Some outstanding publications in 2011

1. Strojnik, M., Omerzu, A., Majkic, A., Mihailovic, P. M., Lukan, J., Bavdek, G., Bratina, G., Cvetko, D., Topolovsek, P., Mihailovic, D.: Ionization energy and energy gap structure of MoSI molecular wires: Kelvin Probe, Ultraviolet Photoelectron Spectroscopy, and Cyclic Voltammetry Measurements. *Langmuir*, 2011, vol. 27, no. 8, 4296–4299
2. Mertelj, A., Rešetič, A., Gyergyek, S., Makovec, D., Čopič, M.: Anisotropic microrheological properties of chain-forming magnetic fluids. *Soft matter*, 2011, vol. 7, issue 1, 118–124
3. Osterman, N., Vilfan, A.: Finding the ciliary beating pattern with optimal efficiency. *Proc. Natl. Acad. Sci. U. S. A.*, 2011, vol. 108, no. 38, 15727–15732
4. Kokot, G., Vilfan, M., Osterman, N., Vilfan, A., Kavčič, B., Poberaj, I., Babič, D.: Measurement of fluid flow generated by artificial cilia. *Biomicrofluidics*, 2011, vol. 5, no. 3, 034103-1-034103-9
5. Milanič, M., Majaron, B.: Three-dimensional Monte Carlo model of pulsed-laser treatment of cutaneous vascular lesions. *J. biomed. opt.*, 2011, vol. 16, no. 12, 128002-1-128002-12
6. Alexandrov, A. S., Kabanov, V. V.: Unconventional high-temperature superconductivity from repulsive interactions: theoretical constraints. *Phys. rev. lett.*, 2011, vol. 106, no. 13, 136403-1-136403-4
7. Beck, M., Klammer, M., Lang, S., Leiderer, P., Kabanov, V. V., Gol'tsman, G. N., Demšar, J.: Energy-gap dynamics of superconducting NbN thin films studied by time-resolved terahertz spectroscopy. *Phys. rev. lett.*, 2011, vol. 107, no. 17, 177007-1-177007-4
8. Toda, Y., Mertelj, T., Mihailović, D.: Femtosecond carrier relaxation dynamics and photoinduced phase separation in k -(BEDT-TTF)₂Cu[N(CN)₂]X (X=Br,Cl). *Phys. rev. lett.*, 2011, vol. 107, no. 22, 227002-1-227002-4

Organization of conferences, congresses and meetings

1. SLONANO 2013, Ljubljana, Slovenia, 23.–25. 10. 2013, coorganizers

Patent granted

1. Andrej Kovič, Adolf Jesih, Aleš Mrzel, The procedure for the synthesis of 4d and 5d (Nb, Mo Ta, W) nitrites of transition metals in the form of quasi-one-dimensional structures, SI23988 (A), Urad RS za intelektualno lastnino, 30.8.2013.

INTERNATIONAL PROJECTS

1. Organization of the International Conference SLONANO 2013, Ljubljana, Slovenia, 23.-25. 10. 2013
Foreign Clients
Prof. Dragan Dragoljub Mihailović
2. 7FP - HINTS; Next Generation Hybrid Interfaces for Spintronic Applications
European Commission
Prof. Viktor Kabanov
3. 7FP - COSIT; Compact High Brilliance Single Frequency Terahertz Source
European Commission
Prof. Marko Zgonik
4. 7FP - MoWSeS; Nanoelectronics based on Two-Dimensional Dichalcogenides
European Commission
Asst. Prof. Christoph Gadermaier
5. 7FP - TRAJECTORY; Coherent Trajectories through Symmetry Breaking Transitions
European Commission
Prof. Dragan Dragoljub Mihailović
6. COINAPO; Composites of Inorganic Nanotubes and Polymers
COST Office
Prof. Dragan Dragoljub Mihailović
7. 5th International Conference on Photoinduced Phase Transitions and Cooperative Phenomena - PIPT5, Bled, Slovenia, 9-13. 6. 2014
Foreign Clients
Prof. Dragan Dragoljub Mihailović
8. Electron-phonon Coupling in High-Temperature Superconductors Determined from Femtosecond Electron Relaxation Rates
Slovenian Research Agency
Prof. Viktor Kabanov
9. Photonic Structures Based on Polymer-Nanoparticle Composites
Slovenian Research Agency
Prof. Irena Drevenšek Olenik
10. Crystal and Film Growth and Time-domain Optical Spectroscopy Investigations of the Superconducting State of the Cuprate Superconductors

11. Slovenian Research Agency
Asst. Prof. Tomaž Mertelj
12. Time Resolved Optical Spectroscopy of Collective Electronically Ordered States in Iron Based Pnictides
Slovenian Research Agency
Prof. Viktor Kabanov
13. Spectrum of the Collective Excitations of the Quasi-one-dimensional Conductors with the Charge Density Wave in the Equilibrium and Nonequilibrium State
Slovenian Research Agency
Prof. Viktor Kabanov

RESEARCH PROGRAMS

1. Light and Matter
Prof. Martin Čopič
2. Dynamics of Complex Nano-systems
Prof. Dragan Dragoljub Mihailović

R&D GRANTS AND CONTRACTS

1. Collective and Molecular Dynamics of Photosensitive Liquid Crystal Elastomers
Dr. Matija Milanič
2. Cosmology in the Lab: Femtosecond Control of Phase Transitions in Real Time
Prof. Dragan Dragoljub Mihailović
3. Optimization Strategies in Biological and Artificial Microfluidic Systems
Asst. Prof. Andrej Vilfan
4. Symmetry Breaking in Real Time
Prof. Dragan Dragoljub Mihailović
5. Center of Competence BioMedical Engineering: CC BME
Prof. Boris Majaron
6. Development of New Ultrafast Change Memory Devices by Femtosecond Multi-pulse

Spectroscopy (ULTRA-MEM-DEVICE)

Dr. Ljupka Stojčevska Malbašič

7. COST MP1205; Advances in Optofluidics: Integration of Optical Control and Photonics with Microfluidics
Dr. Natan Osterman
8. COST MP1302; NanoSpectroscopy
Asst. Prof. Christoph Gadermaier
9. Irradiation and Analysis of Si Samples
Miloš Borovšak, B. Sc.

NEW CONTRACTS

1. Slovenian Tournament of Young Physicists
Ames, d. o. o.
Prof. Irena Drevenšek Olenik
2. 5th International Conference on Photoinduced Phase Transitions and Cooperative Phenomena - PIPPT5, Bled, Slovenia, 9-13. 6. 2014
Lek, d. d.
Prof. Dragan Dragoljub Mihailović
3. Organization of the International Conference SLONANO 2013
Lek, d. d.
Prof. Dragan Dragoljub Mihailović

VISITORS FROM ABROAD

1. Andrei Shumilin, Ioffe Physical-Technical Institute of the Russian Academy of Sciences, St. Petersburg, Russia, 11. 1.-10. 4. 2013
2. Prof. David Sherrington, University of Oxford, Oxford, Great Britain, 13.-14. 2. 2013
3. Nataša Vujičić, Institute of Physic, Zagreb, Croatia, 4.-31. 3. 2013
4. Dr. Sumeet Kumar, Innovation Factory SRL, Trieste, Italy, 5. 3.-31. 5. 2013
5. Prof. Serge Brazovski, Prof. Nathalie Kirova Brazovski, Université Paris Sud, Paris, France, 22. 4.-20. 5. 2013
6. Prof. Hans Kuzmany, University of Vienna, Vienna, Austria, 21.-22. 5. 2013
7. Prof. Xin Yao, Shanghai Jiao Tong University, Shanghai, China, 30. 5.-13. 6. 2013
8. Prof. Zhuan Xu, Zhejiang University, Zhejiang Province, China, 15.-20. 6. 2013
9. Katarina Tlučková, Faculty of Science, P.J. Šafarik University, Kosice, Slovakia, 11. 7. 2013
10. Cui Wei, Nakai University, Tianjin, China, 15. 7.-15. 8. 2013
11. Prof. Aleksander Balanov, Loughborough University, Loughborough, Great Britain, 30. 7.-1. 8. 2013
12. Daniele Vella, University of Pisa, Pisa, Italy, 28.-30. 8. 2013
13. Victor Vega, University of Salamanca, Salamanca, Spain, 26.-28. 8. 2013
14. Prof. Jan Lagerwall, Prof. Guisy Scalia, Seoul National University, Seoul, South Korea, 16.-18. 9. 2013
15. Andrei Shumilin, Ioffe Physical-Technical Institute of the Russian Academy of Sciences, St. Petersburg, Russia, 15. 10.-15. 12. 2013

STAFF
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1. Prof. Martin Čopič*
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4. Prof. Viktor Kabanov
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8. Asst. Prof. Tomaž Mertelj
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15. Dr. Mojca Vilfan
16. Prof. Marko Zgonik*

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23. Dr. Martin Strojnik

Postgraduates

24. Miloš Borovšak, B. Sc.
25. Tetiana Borzda, B. Sc.
26. Jože Buh, B. Sc.
27. *Dr. Gašper Kokot, left 01.04.13*
28. Andrej Kovič, B. Sc.
29. Anna Pogrebna, B. Sc.
30. Matej Prijatelj, B. Sc.
31. Peter Topolovšek, B. Sc.
32. Victor Vega Mayoral, B. Sc.
33. Daniele Vella, B. Sc.
34. Luka Vidovič, B. Sc.

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35. Damjan Svetin, B. Sc.
36. Petra Šutar, B. Sc.

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37. Martina Knavs, B. Sc.
38. Janja Milivojević
39. Nataša Zakrajšek, B. Sc.

Note:

* part-time JSI member

BIBLIOGRAPHY
ORIGINAL ARTICLE

1. K. Adlem, Martin Čopič, G. R. Luckhurst, Alenka Mertelj, O. Parri, R. M. Richardson, B. D. Snow, B. A. Timimi, Rachel P. Tuffin, David Wilkes, "Chemically induced twist-bend nematic liquid crystals, liquid crystal dimers, and negative elastic constants", *Phys. rev., E Stat. nonlinear soft matter phys.*, vol. 88, no. 2, pp. 022503-1-022503-8, 2013.
2. Vid Agrež, Ferdinand Bammer, Boštjan Podobnik, Rok Petkovšek, "Influence of the retardation of the multiplexing element in a dual channel Q-switched laser", *Appl. phys., B Lasers opt.*, vol. 112, issue 1, pp. 73-81, 2013.
3. Vladimir V. Baranov, A. G. Balanov, Viktor V. Kabanov, "Dynamics of resistive state in thin superconducting channels", *Phys. rev., B, Condens. matter mater. phys.*, vol. 87, no. 17, pp. 174516-1-174516-7, 2013.
4. Martin Čopič, "Nematic phase of achiral dimers spontaneously bends and twists", *Proc. Natl. Acad. Sci. U. S. A.*, vol. 110, no. 40, pp. 15855-15856, 2013.
5. Martin Čopič, Mojca Vilfan, Alenka Mertelj, "Flow and anchoring effects on nematic fluctuations in confined geometry", In: Proceedings of Frontiers of Soft Matter Symposium, honoring professor Noel A. Clark on the occasion of his 70th birthday, Boulder, Colorado, May 16-18, 2012, *Liq. Cryst.*, vol. 40, no. 12, pp. 1646-1654, 2013.
6. M. De Luca, Antonio DeSimone, Andrej Petelin, Martin Čopič, "Sub-stripe pattern formation in liquid crystal elastomers: experimental observations and numerical simulations", *J. mech. phys. solids*, vol. 61, no. 11, pp. 2161-2177, 2013.
7. M. P. M. Dean *et al.* (14 authors), "Persistence of magnetic excitations in $\text{La}_{(2-x)}\text{Sr}_x\text{CuO}_4$ from the undoped insulator to the heavily overdoped

- non-superconducting metal", *Nature materials*, vol. 12, issue 11, pp. 1019-1023, 2013.
8. Helena Gradišar, Sabina Božič, Tibor Doles, Damjan Vengust, Iva Hafner Bratkovič, Alenka Mertelj, Ben Webb, Andrej Šali, Sandi Klavžar, Roman Jerala, "Design of a single-chain polypeptide tetrahedron assembled from coiled-coil segments", *Nature chemical biology*, vol. 9, issue 6, pp. 362-366, 2013.
 9. Marko Gregorc, Hui Li, Valentina Domenici, Gabriela Ambrožič, Martin Čopič, Irena Drevenšek Olenik, "Optical properties of light-sensitive liquid-crystal elastomers in the vicinity of the nematic-paranematic phase transition", *Phys. rev., E Stat. nonlinear soft matter phys.*, vol. 87, iss. 2, pp. 022507-1-022507-7, 2013.
 10. Tina Ilc, Primož Šket, Janez Plavec, Mateus Webba da Silva, Irena Drevenšek Olenik, Lea Spindler, "Formation of G-wires: the role of G:C-base pairing and G-quartet stacking", *The journal of physical chemistry. C, Nanomaterials and interfaces*, vol. 117, iss. 44, pp. 23208-23215, 2013.
 11. Miloš Knežević, Mark Warner, Martin Čopič, Antoni Sánchez-Ferrer, "Photodynamics of stress in clamped nematic elastomers", *Phys. rev., E Stat. nonlinear soft matter phys.*, vol. 87, iss. 6, pp. 062503-1-062503-7, 2013.
 12. Janez Kogovšek, Maja Remškar, Aleš Mrzel, Mitjan Kalin, "Influence of surface roughness and running-in on the lubrication of steel surfaces with oil containing MoS₂ nanotubes in all lubrication regimes", *Tribol. int.*, vol. 61, pp. 40-47, May 2013.
 13. Gašper Kokot, Alexey Snezhko, Igor S. Aranson, "Emergent coherent states and flow rectification in active magnetic colloidal monolayers", *Soft matter*, vol. 9, no. 29, str. 6757-6760, 2013.
 14. Andrej Kovič, Damjan Vengust, Mojca Vilfan, Aleš Mrzel, "Controlled self-decoration of Mo₅S₈I₂ (8.2 ≤ y + z ≤ 10) nanowires and their transformation to MoS₂ nanotubes with gold nanoparticles", *J. nanopart. res.*, vol. 15, no. 7, pp. 1791-1-1791-13, 2013.
 15. M. Labardi, J. H. Park, H. K. Nguyen, D. Prevosto, Chae-yong Seong, Aleš Mrzel, Giusy Scalia, "Local dielectric spectroscopy of polyvinylpyrrolidone Mo₆S₂I₈ nanowire composite", *J. non-cryst. solids*, vol. 379, pp. 224-228, 2013.
 16. Christof B. Mast, Natan Osterman, Dieter Braun, "Could thermal gradients drive molecular evolution?", *Curr. org. chem.*, vol. 17, no. 16, pp. 1732-1737, 2013.
 17. Johann G. Meier, Aleš Mrzel, Margarita Canales, Pilar Gonzalvo, Noelia Alcalá, "Tribological properties of composites of polyamide-6 and nanotubes of MoS₂, and nanowires of MoO₃(3x) and Mo₆S₂I₈", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, no. 11, pp. 2307-2313, 2013.
 18. Alenka Mertelj, Darja Lisjak, Mihael Drogenik, Martin Čopič, "Ferromagnetism in suspensions of magnetic platelets in liquid crystal", *Nature (Lond.)*, vol. 504, no. 7479, pp. 237-241, 2013.
 19. Tomaž Mertelj, Primož Kušar, Viktor V. Kabanov, P. Giraldo-Gallo, Ian R. Fisher, Dragan Mihailović, "Incoherent topological defect recombination dynamics in TbTe₃: T. Mertelj ... [et al.]", *Phys. rev. Lett.*, vol. 110, no. 15, pp. 156401-1-156401-5, 2013.
 20. Tomaž Mertelj, Ljupka Stojčevska, J. Karpinski, Dragan Mihailović, "Normal state bottleneck and nematic fluctuations from femtosecond quasiparticle relaxation dynamics in Sm(Fe,Co)AsO", *Phys. rev., B, Condens. matter mater. phys.*, vol. 87, no. 17, pp. 174525-1-174525-6, 2013.
 21. Dragan Mihailović, Tomaž Mertelj, Viktor V. Kabanov, Serguei Brazovskii, "Coherent topological defect dynamics and collective modes in superconductors and electronic crystals", *J. phys., Condens. matter*, vol. 25, no. 40, pp. 404206-1-404206-9, 2013.
 22. Matija Milanič, Boris Majaron, "Characterization of laser tattoo removal treatment using pulsed photothermal radiometry", *LAHA*, vol. 2013, no. 1, pp. 68-74, 2013.
 23. Matija Milanič, Boris Majaron, "Energy deposition profile in human skin upon irradiation with a 1,342 nm Nd:YAP laser", *Lasers surg. med.*, vol. 45, no. 1, pp. 8-14, 2013.
 24. Vid Novak, Boštjan Podobnik, Janez Možina, Rok Petkovšek, "Analysis of the thermal management system for a pump laser", *Appl. therm. eng.*, vol. 57, iss. 1/2, pp. 99-106, Aug. 2013.
 25. Zdenka Peršin, Miha Devetak, Irena Drevenšek Olenik, Alenka Vesel, Miran Mozetič, Karin Stana-Kleinschek, "The study of plasma's modification effects in viscose used as an absorbent for wound-relevant fluids", *Carbohydr. polym.*, vol. 97, iss. 1, pp. 143-151, 14. Aug. 2013.
 26. Andrej Petelin, Martin Čopič, "Nematic fluctuations and semisoft elasticity in liquid-crystal elastomers", *Phys. rev., E Stat. nonlinear soft matter phys.*, vol. 87, no. 6, pp. 062509-1-062509-19, 2013.
 27. Matejka Podlogar, Damjan Vengust, Jacob J. Richardson, Martin Strojnik, Matjaž Mazaj, Gregor Trefalt, Nina Daneu, Aleksander Rečnik, Slavko Bernik, "Parametric study of seed-layer formation for low-temperature hydrothermal growth of highly oriented ZnO films on glass substrates", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, issue 6, pp. 1083-1092, 2013.
 28. Denis Rajh, Sergii Shelestiuk, Alenka Mertelj, Aleš Mrzel, Polona Umek, Silvia Irusta, A. Zak, Irena Drevenšek Olenik, "Effect of inorganic 1D nanoparticles on electrooptic properties of 5CB liquid crystal", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, no. 11, pp. 2328-2334, 2013.
 29. Marius Reinecker, Armin Fuith, Viktor Soprunyuk, Antoni Sánchez-Ferrer, Aleš Mrzel, Renato Torre, Wilfried Schranz, "Influence of inorganic nanoparticles on the glass transitions of polyurea elastomers", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, no. 11, pp. 2320-2327, 2013.
 30. Martin Rigler, Marko Zgonik, Marc P. Hoffmann, Ronny Kirste, Milena Bobea, R. Collazo, Zlatko Sitar, Seiji Mita, Michael Gerhold, "Refractive index of III-metal-polar and N-polar AlGaIn waveguides grown by metal organic chemical vapor deposition", *Appl. phys. Lett.*, vol. 102, iss. 22, pp. 221106-1-221106-5, 2013.
 31. Ljupka Stojčevska, Tomaž Mertelj, Jiun-Haw Chu, Ian R. Fisher, Dragan Mihailović, "Dynamics of photoexcited carriers in Ba(Fe_{1-x}Co_x)₂As₂ single crystals with spin-density-wave ordering", *J. supercond. nov. magn.*, vol. 26, issue 8, pp. 2593-2596, 2013.
 32. Blaž Tašič, Wei Li, Antoni Sánchez-Ferrer, Martin Čopič, Irena Drevenšek Olenik, "Light-induced refractive index modulation in photoactive liquid-crystalline elastomers", *Macromol. chem. phys.*, vol. 214, iss. 23, pp. 2744-2751, 2013.
 33. Y. Toda, Tomaž Mertelj, Primož Kušar, T. Kurosawa, Migaku Oda, M. Ido, Dragan Mihailović, "Impact of pseudogap on photoinduced superconducting phase transition in underdoped Bi2212", In: Proceedings of the 9th International Conference on New Theories, Discoveries and Applications of Superconductors and Related Materials, New3SC-9, September 16-20, 2012, Frascati, Rome, Italy, *Phys. C*, vol. 493, pp. 112-113, 2013.
 34. Luka Vidovič, Matija Milanič, Boris Majaron, "Influence of the sampling rate and noise characteristics on prediction of the maximal safe laser exposure in human skin using pulsed photothermal radiometry", In: Selected papers of the 16th International Conference on Photoacoustic and Photothermal Phenomena, November 27 - December 1, 2011, Mérida, Yucatán, México, *Int. J. Thermophys.*, vol. 34, no. 8/9, pp. 1549-1558, 2013.
 35. Xian Wu, Leiting Pan, Ying Liu, Pengchong Jiang, Imshik Lee, Irena Drevenšek Olenik, Xinzhen Zhang, Jingjun Xu, "Cell-cell communication induces random spikes of spontaneous calcium oscillations in multi-BV-2 microglial cells", *Biochem. biophys. res. commun.*, vol. 431, iss. 4, pp. 664-669, 2013.
 36. Ming Yang, Qiang Wu, Jiwei Qi, Irena Drevenšek Olenik, Zhandong Chen, Yusong Pan, Jingjun Xu, "Microstructured polymer-based substrates with broadband absorption for surface-enhanced Raman scattering", *J. Raman spectrosc.*, vol. 44, iss. 12, pp. 1678-1681, 2013.
 37. Klemen Žbontar, Matjaž Mihelj, Boštjan Podobnik, Franc Povše, Marko Munih, "Dynamic symmetrical pattern projection based laser triangulation sensor for precise surface position measurement of various material types", *Appl. opt.*, vol. 52, no. 12, pp. 2750-2760, 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

1. Luka Vidovič, Matija Milanič, Lise L. Randeberg, Boris Majaron, "Characterization of the bruise healing process using pulsed photothermal radiometry", In: *Novel biophotonic techniques and applications II: 12-14 May 2013 Munich, Germany*, (Progress in biomedical optics and imaging, vol. 14, no. 51), (Proceedings of SPIE, vol. 8801), Alex Vitkin, ed., Arjen Amelink, ed., Bellingham, SPIE, 2013, pp. 880104-1-880104-10.

PUBLISHED CONFERENCE CONTRIBUTION

1. Raluca C. Frunza, Martin Strojnik, Marko Jankovec, Marko Topič, Barbara Malič, "Investigation of the structural, optical and electrical properties of Ta₂O₅-rich thin films from solution", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference*, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 268-277.

2. Marko Gregorc, Valentina Domenici, Gabriela Ambrožič, Martin Čopič, Irena Drevenšek Olenik, "Hidden holograms in light-sensitive liquid crystal elastomers", In: *The proceedings of the Austrian - Slovenian Polymer Meeting 2013*, Austrian - Slovenian Polymer Meeting - ASPM 2013, 3-5 April 2013, Bled, Slovenia, Majda Žigon, ed., Teja Rajšp, ed., Ljubljana, Centre of Excellence PoliMaT, 2013, pp. 89-90.
3. Andrej Kovič, Sumeet Kumar, Aleš Mrzel, Mojca Vilfan, "Single-step decoration of MoSI based nanowires with platinum nanoparticles", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al., Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 304-312.
4. Aleš Mrzel, Andrej Kovič, Adolf Jesih, Mojca Vilfan, "Decoration of MoSI nanowires with platinum nanoparticles and transformation into molybdenum-nanowire based networks", In: *3rd International Conference Nanomaterials: Applications & Properties, 2013, NAP-2013, September 16-21, 2013, Alushta, the Crimea, Ukraine*, (Proceedings of the international conference nanomaterials, vol. 2, no. 2, 2013), Sumy, Sumy State University, 2013, vol. 2, no. 2, pp. 02PCN19-1-02PCN19-4, 2013.
5. Peter Naglič, Luka Vidovič, Matija Milanič, Lise L. Randeberg, Boris Majaron, "Applicability of diffusion approximation in analysis of diffuse reflectance spectra from healthy human skin", In: *Biophotonics - Riga 2013: 26-31 August 2013, Riga, Latvia*, (Progress in biomedical optics and imaging, vol. 15, no. 43), (Proceedings of SPIE, vol. 9032), Janis Spigulis, ed., Ilona Kuzmina, ed., Bellingham, SPIE, 2013, pp. 90320N-1-90320N-12.
6. Jan Premru, Matija Milanič, Boris Majaron, "Monte Carlo simulation of radiation transfer in human skin with geometrically correct treatment of boundaries between different tissues", In: *Optical interactions with tissue and cells XXIV: 15 February 2013, San Francisco, California, United States*, (Proceedings of SPIE, vol. 8579), E. Duco Jansen, ed., Robert J. Thomas, ed., Bellingham, SPIE, 2013, pp. 85790Z-1-85790Z-13.
7. Lise L. Randeberg, Martin Denstedt, Lukasz Paluchowski, Matija Milanič, Brita S. Pukstadt, "Combined hyperspectral and 3D characterization of non-healing skin ulcers", In: *The Colour and Visual Computing Symposium 2013, CVCS 2013*, [S. l., s. n.], 2013, 6 pp..
8. Luka Vidovič, Boris Majaron, "Elimination of single-beam substitution error in diffuse reflectance measurements using an integrating sphere", In: *Photonic therapeutics and diagnostics IX: 21 March 2013, San Francisco, California, United States*, (Proceedings of SPIE, vol. 8565), Andreas Mandelis, ed., Bellingham, SPIE, 2013, pp. 85650I-1-85650I-8.
9. Luka Vidovič, Matija Milanič, Boris Majaron, "Assessment of hemoglobin dynamics in traumatic bruises using temperature depth profiling", In: *Biophotonics - Riga 2013: 26-31 August 2013, Riga, Latvia*, (Progress in biomedical optics and imaging, vol. 15, no. 43), (Proceedings of SPIE, vol. 9032), Janis Spigulis, ed., Ilona Kuzmina, ed., Bellingham, SPIE, 2013, pp. 90320J-1-90320J-12.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Lucija Čoga, Miha Devetak, Stefano Masiero, Gian Piero Spada, Irena Drevenšek Olenik, "Specific behaviour of guanosine in liponucleoside thin films", In: *Guanine quartets: structure and application*, Wolfgang Fritzsche, ed., Lea Spindler, ed., Cambridge, RSC Publishing, cop. 2013, pp. 154-163.
2. Lea Spindler, "Solution dynamics and structure of G-quadruplexes studied by dynamic light scattering", In: *Guanine quartets: structure and application*, Wolfgang Fritzsche, ed., Lea Spindler, ed., Cambridge, RSC Publishing, cop. 2013, pp. [121]-134.
3. Andrej Vilfan, Dušan Babič, Blaž Kavčič, Gašper Kokot, Natan Osterman, Igor Poberaj, Mojca Vilfan, "Measurement of fluid flow generated by artificial cilia", In: *Artificial cilia*, (RSC nanoscience & nanotechnology), Jaap M. J. de Toonder, ed., Patrick R. Onck, ed., Cambridge, The Royal Society of Chemistry, 2013, pp. 244-258.

PATENT APPLICATION

1. Adolf Jesih, Andrej Kovič, Aleš Mrzel, *Method for a synthesis of quasi one-dimensional structures of 4D and 5 D (Nb, Mo, Ta, W) transition metals*, WO2012177224 (A3), World Intellectual property organization, 21.2.2013.

PATENT

1. Andrej Kovič, Adolf Jesih, Aleš Mrzel, *The procedure for the synthesis of 4d and 5d (Nb, Mo, Ta, W) nitrides of transition metals in the form of quasi-one-dimensional structures*, SI23988 (A), Urad RS za intelektualno lastnino, 30.8.2013.

MENTORING

1. Vladimir V. Baranov, *Dynamics of the resistive state in the nonequilibrium superconductors and relaxation of the hot electrons in metals*: doctoral dissertation, Ljubljana, 2013 (mentor Viktor Kabanov).
2. Gašper Kokot, *Measuring forces with magneto-optical tweezers in biological and biomimetic systems*: doctoral dissertation, Ljubljana, 2013 (mentor Andrej Vilfan).
3. Ljupka Stojchevska, *Femtosecond relaxation dynamics in collective-electronic-state materials: cuprate and iron-pnictide superconductors and charge-density wave systems*: doctoral dissertation, Ljubljana, 2013 (mentor Tomaž Mertelj; co-mentor Dragan D. Mihailović).
4. Martin Strojnik, *Charge transport in MoS₂/Si nanowires and related systems*: doctoral dissertation, Ljubljana, 2013 (mentor Dragan D. Mihailović).
5. Tadeja Forjanič, *Reconstruction of tomographic images based on pulsed photothermal radiometry*: master's thesis, Ljubljana, 2013 (mentor Boris Majaron).
6. Peter Naglič, *Determination of human skin structure using diffuse reflectance spectroscopy*: master's thesis, Ljubljana, 2013 (mentor Boris Majaron).

DEPARTMENT OF REACTOR PHYSICS

F-8

During the past year we have been working mainly on:

- *theoretical, experimental and applied reactor physics*
- *plasma physics*
- *neutron transport calculations*
- *semiconductor physics*
- *medical physics*

In the field of **reactor physics** we continued our research on the development of new methods for the analysis of research and power reactors.

In collaboration with CEA Cadarache a series of experiments was carried out at the TRIGA reactor for the determination of the kinetic parameters of the reactor. At the JSI TRIGA a simultaneous measurement with four fission cells was first performed and in parallel a new SPECTRON device, developed by the CEA, was also tested. Within the same project we improved the method of measuring the control rod worth using the rod-insertion method.

Within the scope of another project in collaboration with the CEA we tested the IRDF neutron dosimetry library, to which we contributed previously. We compared the computational results with activation measurements on the TRIGA reactor in the process of neutron spectrum unfolding for different irradiation channels in the reactor.

In the framework of the environmental monitoring control for non-proliferation in nuclear Safeguards, the Department Analyse, Surveillance, Environment (DASE) of the Commissariat à l'Énergie Atomique et aux Énergies Alternatives (CEA) has developed analytical techniques to detect traces of uranium and plutonium in micrometric particles. The method is called The Fission Track-Thermoionization Mass Spectrometry (FT-TIMS) and among others requires the irradiation of the sample under a well-thermalized neutron flux. The aim of the collaboration between CEA and the Jožef Stefan Institute in Slovenia is to develop an irradiation channel/device in the TRIGA reactor with the required neutronic characteristics, which will then be used for irradiation of CEA - DASE samples for the FT-TIMS method under well-defined conditions.

Our involvement in international projects included the evaluation of nuclear data and their covariance information. We completed the evaluation of the nuclear data file for ^{55}Mn and offered it to the OECD/NEA Data Bank for inclusion in the European JEFF-3.2 library, which will be released in 2015. We completed the selection of integral benchmarks for the validation of nuclear data for ^{238}U and the isotopes of Fe and performed sensitivity/uncertainty calculations for selected test cases within the OECD/NEA Working Group WPEC SG-33.

The participation continued in the scope of the international projects of OECD/NEA UAM, WPEC-SG33, WPEC SG38, WPEC SG39 as well as the EC projects ANDES in F4E. The methodologies for nuclear data sensitivity and uncertainty analysis were further improved and applied to fission reactors (criticality safety studies, delayed neutrons, uncertainty in the effective delayed neutron fraction, in prompt and delayed fission neutron fraction) and the future fusion reactor ITER. In the area of benchmark experiments we started the cooperation on the new copper benchmark to be performed at the FNG DT facility in ENEA Frascati and continued the participation in the international shielding benchmark database SINBAD under development at OECD/NEA, covering the neutron/gamma shielding experiment for fission, fusion and accelerator applications. In cooperation with the OECD/NEA and F4E we developed a computer environment facilitating the use of transport, sensitivity and uncertainty codes and the graphical package for the visualisation of sensitivity analysis results. In the scope of the UAM project of the OECD/NEA we organised an intercomparison study for the sensitivity codes based on the SNEAK critical experiments and proposed a similar intercomparison for the effective delayed neutron fraction.

Reactor Physics Department researchers also provided technical support in 2013 for the safe operation of the Krško nuclear power plant (NPP). We have independently confirmed nuclear design calculations for the fuel cycle 27 and performed start-up tests after the fuel reloading. As an authorised expert organization in the field of radiation and nuclear safety we performed an independent expertise on a NPP Krško reload safety evaluation for the cycle 27 and provided an expert review of the analysis and testing report for capsule T from the NPP Krško reactor vessel irradiation surveillance program.

In the field of **plasma physics** we have strengthened our collaboration with the University of Sofia in the development of a modern plasma characterization method with a Langmuir probe in magnetized plasma. This approach has been successfully implemented in measurements on the Compass tokamak. This work is also important



Head:

Asst. Prof. Andrej Trkov

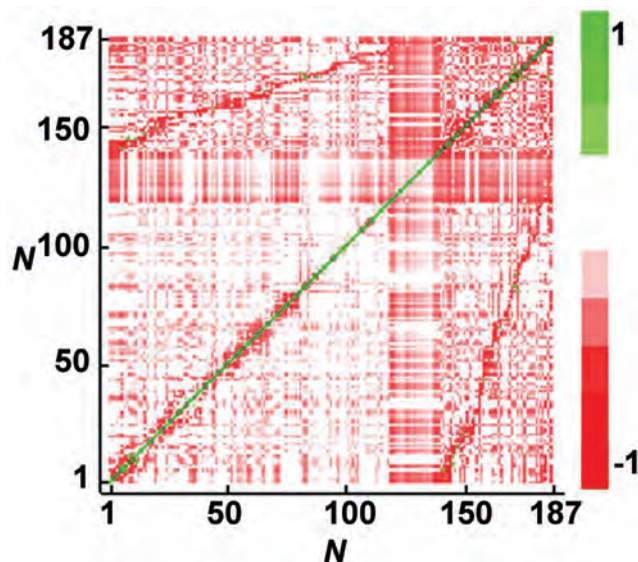


Figure 1: Example of a resonance parameter correlation matrix. In figure: correlations between γ widths of ^{55}Mn resolved resonances from ENDF/B-VII.1 library ($N=1$ corresponds to lowest energy).

for plasma diagnostics in larger fusion devices and it complements well our work on the ball-pen type of probe and emissive probe for use in tokamaks. We collaborate in these two areas with IPP Prague and the University of Innsbruck. We have helped the latter to design an emissive probe for use in tokamaks and provided theoretical support. Therefore, our more fundamental research was still focused on the development of computational models of plasma in front of an electron-emitting electrode, but we also worked on gas-filled diode breakdown. A lot of work

was done using computer simulations; we have successfully carried out a comparison between kinetic plasma simulations of our experimental device (a linear magnetized plasma device) with Langmuir probe measurements. We have also conducted simulations of plasma in front of an electrode for small potential drops, i.e., close to the plasma potential using a specially adapted particle-in-cell code.

In the field of **neutron transport calculations for fusion reactors**, we continued and expanded our work for JET - Joint European Torus, the largest fusion reactor. Co-workers of the Reactor Physics Division have, in collaboration with the JET staff, performed calculations of the neutron field inside the torus for various past torus configurations (1986-2013) and thereby determined the differences in the historical response of the detectors. In doing so, we discovered a significant error in most of the past calculations of the detector response, arising from the limited computing capabilities of the 20th century, which could be eliminated with the use of the most recent techniques. The JSI researchers are co-responsible for the maintenance of a model of JET, to be used for transport calculations by the Monte Carlo method.

The calibration of detectors with a neutron source was one of the most important projects in JET in 2013, in which co-workers of F8 were responsible for the supporting calculations for the evaluation of the uncertainty of the calibration and the calculation of the corrections due to circumstances that are different during operation, e.g., additional structures inside and outside the Tokamak, neutron spectra, shape of the neutron source, etc.

The long-term work on the JET gamma ray camera was concluded with calculations of the attenuation of neutrons in the neutron attenuator of the horizontal camera and of the contribution due to the scattered neutrons within the attenuator.

The analysis of the Grenoble-led slowing-down experiment has been performed. One of the noticeable achievements was to optimize the limit between the resolved and unresolved resonance regions for the ^{197}Au cross-section.

Our research in the field of **medical physics** was focused in the analysis of Positron Emission Tomography (PET) images, image-guided cancer therapy and modelling. One significant part of our research work was dedicated to the research of fluorothymidine (FLT) tissue uptake stabilization during the PET imaging. We experimentally and theoretically demonstrated that the stabilization time for PET images is inversely proportional to the FLT tissue uptake parameters (SUV, the kinetic influx parameters), which could help in determining the optimal time interval for static PET imaging. Another part of our research work was dedicated to the comparison of two radiopharmaceuticals (sodium fluoride (NaF) and fluorodeoxyglucose (FDG)) for the PET-based evaluation of bone metastases treatment response. The basic finding was that the late NaF and FDG responses are consistently correlated, while earlier responses may be different. The third part of our research work (connected with the successful completion of a master's thesis) covered a modelling of tumour response to treatment with the anti-angiogenic targeted drug Axitinib. With our model we reproduced the reduction of cell proliferation during the therapy and proliferative flare after the therapy discontinuation, which was also experimentally verified. Clinical data for those three projects were obtained from the University of Wisconsin. We also worked on the development of an algorithm for a non-invasive determination of the input function (time dependence of radiopharmaceutical activity in the blood plasma) for kinetic modelling. We developed a novel algorithm, based on factor analysis, which was tested on experimental data obtained from The National Institute of Mental Health, USA. We have reliably determined the input function from the PET images even when the diameter of the largest artery in the field of view was comparable to the resolution of the PET scanner.

Some outstanding publications in the past year

1. Žerovnik, G., Capote, R., Trkov, A.: On random sampling of correlated resonance parameters with large uncertainties. Nuclear instruments and methods in physics research. Section A, Accelerators, spectrometers, detectors and associated equipment, ISSN 0168-9002. [Print ed.], 2013, vol. 723, 89–98

2. Žerovnik, G., Trkov, A., Smith, Donald L., Capote, R.: Transformation of correlation coefficients between normal and lognormal distribution and implications for nuclear applications. Nuclear instruments and methods in physics research. Section A, Accelerators, spectrometers, detectors and associated equipment, ISSN 0168-9002. [Print ed.], 2013, vol. 727, 33–39
3. Kodeli, Ivan A.: Sensitivity and Uncertainty in the Effective Delayed Neutron Fraction (β_{eff}), Nuclear Instruments and Methods in Physics Research A 715(2013)70–78
4. Chadwick, M. B., Trkov, A., et al.: ENDF/B-VII.1 nuclear data for science and technology : cross sections, covariances, fission product yields and decay data. Nuclear data sheets, ISSN 0090-3752, 2011, no. 12, vol. 112, 2887–2996
5. Gruenwald, J., Tskhakaya, D., Kovačič, J., Čerček, M., Gyergyek, T., Ionita, C., Schrittwieser, R.: Comparison of measured and simulated electron energy distribution functions in low-pressure helium plasmas. Plasma sources science & technology, ISSN 0963-0252, Feb. 2013, vol. 22, no. 1, 015023

INTERNATIONAL PROJECTS

1. Reports on Thermal Neutron Induced SEU Susceptibility of PXIe and cRIO Fast Controller Components
ITER Organization
Dr. Luka Snoj
2. 7FP - EURATOM - ANDES; Accurate Nuclear Data for Nuclear Energy Sustainability
European Commission
Asst. Prof. Andrej Trkov
3. F4E-FPA-168-01; Nuclear Data Improvements and Development of Tools - Nuclear Data Evaluation
European Commission
Prof. Ivan Aleksander Kodeli
4. Specific Grant Agreement; Cu Experiment and TBM Nuclear Instrumentation
European Commission
Prof. Ivan Aleksander Kodeli
5. 7FP - CHANDA; solving CHallenges in Nuclear Data
European Commission
Prof. Ivan Aleksander Kodeli
6. 7FP - EURATOM; Public Information; Research Unit - Administration and Services - RU-FU; 3211-08-000102, FU07-CT-2007-00065
Ministry of Education, Science and Sport
Asst. Prof. Andrej Trkov
7. 7FP - EURATOM; Improvement of Diagnostic in Edge Plasmas of Fusion Devices - 1.2.1.-FU; Annex 2 to Contract 3211-08-000102, FU07-CT-2007-00065
Ministry of Higher Education, Science and Technology
Prof. Tomaž Gyergyek
8. 7FP - EURATOM; Neutronic Studies for DEMO - 4.10.2. FU
Ministry of Higher Education, Science and Technology
Dr. Igor Lengar
9. 7FP - EURATOM, MHEST Association; Neutron Calculation for Fusion Reactor, JET MCNP Model - 3.4.1.-FU, TA JW12-FJ-JET, JW12-NFT-MHST
Ministry of Education, Science and Sport
Dr. Igor Lengar
10. EURATOM-MHEST, WP2013/3.4.3., 3.4.4., 3.4.5 Neutron Calculations for Fusion Reactor
Ministry of Education, Science and Sport
Dr. Igor Lengar
11. 3.4.2-FU, EURATOM-MHEST, Neutron Calculations for Fusion Reactor-JET Neutron Source Calibration
Ministry of Education, Science and Sport
Dr. Luka Snoj
12. 3.4.1-FU13, EURATOM-MHEST, JET MCNP Model Neutron Calculations for Fusion Reactor
Ministry of Education, Science and Sport
Dr. Igor Lengar
13. Ministry of Education, Science and Sport
Dr. Igor Lengar
14. 7FP - EURATOM-MHEST, WP12-SYS-02-T06-01/MESCS/PS, Tritium Breeding Ratio Assessment
Ministry of Education, Science and Sport
Dr. Igor Lengar
15. 7FP - EURATOM-MHEST, Pref. Supp. WP13-IPH-A06-P1 -02/MESCS/PS, SOL Transport and Divertor Heat Loads in Steady State and Unmitigated ELMs
Ministry of Education, Science and Sport
Prof. Tomaž Gyergyek
16. Feasibility Study and Installation of Thermal Neutron Driven 14 MeV Neutron Converter into the TRIGA Research Reactor
IAEA - International Atomic Energy Agency
Dr. Luka Snoj
17. Training and Tutoring for Experts of the NRAs and their TSOs for Developing and Strengthening their Regulatory and Technical Capabilities - INSC Project MC.03/10 - LOT 1: Training and Tutoring for Nuclear Regulatory Authorities and their TSO's
ITER-consult Srl
Dr. Luka Snoj
18. Integral Measurements for the Validation of the Dosimetry Cross Sections; F41031 Testing and Improving the IAEA International Dosimetry Library for Fission and Fusion (IRDFF)
IAEA - International Atomic Energy Agency
Asst. Prof. Andrej Trkov
19. IAEA Fellowship for Ms Widad Kouidri Titouche, ALG/10055, C6/ALG/10055, 15.04.-14.07.13
IAEA - International Atomic Energy Agency
Asst. Prof. Andrej Trkov
20. Evaluation and Validation of the Resonance Parameters for Structural Materials
Slovenian Research Agency
Asst. Prof. Andrej Trkov
21. Experimental Verification of Kinetic Parameters of the TRIGA Reactor and Upgrade of the Digital Meter of Reactivity
Slovenian Research Agency
Dr. Igor Lengar
22. Experimental Verification of Neutron Flux Form Factors and Qualification of a New Wide Range Multichannel Neutron Instrumentation
Slovenian Research Agency
Dr. Gašper Žerovnik
23. Design of Irradiation Device for FT-TIMS Method at the JSI TRIGA Mark II Reactor
Slovenian Research Agency
Dr. Luka Snoj

RESEARCH PROGRAM

1. Reactor Physics
Asst. Prof. Andrej Trkov

R&D GRANTS AND CONTRACTS

1. Neutron Calculations for Use with Neutron Diagnostics - Application to the JET Fusion Reactor
Dr. Igor Lengar
2. Functionalization of Biomedical Samples by Thermodynamic Non-equilibrium Gaseous Plasma
Prof. Milan Čerček
3. Calculations to Support Neutron Monitor Calibration - JET Fusion Reactor Example Case
Dr. Luka Snoj
4. Determination of Computational Framework for Treating Gas Discharges in Case of Surge Protection Gas Discharge Tubes
Dr. Jernej Kovačič
5. Irradiation and Analysis of Si Samples
Asst. Prof. Andrej Trkov

NEW CONTRACTS

1. Reload Operational Core Analysis, Post Refueling Nuclear Design Check Tests, PIS and KFSS Cycle Specific Data for Future Fuel Cycles
Krško Nuclear Power Plant
Dr. Marjan Kromar
2. Expert Review of the Analysis and Testing Report for Capsule T for the Krško Reactor Vessel Irradiation Surveillance Program
Krško Nuclear Power Plant
Dr. Marjan Kromar
3. Development of Advanced Methods for the Description of Dynamic Processes in a Nuclear Reactor
Krško Nuclear Power Plant
Asst. Prof. Andrej Trkov

VISITORS FROM ABROAD

1. Dr. Roberto Capote Noy, International Atomic Energy Agency, Vienna, Austria, 31. 3.–8. 4. 2013
2. Widad Kouidri Titouche, Commissariat à l'énergie atomique (COMENA), Centre de recherche nucléaire de Birine, Birine, Algeria, 14. 4.–13. 7. 2013
3. Dr. Patrick Sauvan, dr. Francisco Ogando, Departamento de Ingeniería, Universidad Nacional de Educación a Distancia (UNED), Madrid, Spain, 8. 4.–12. 4. 2013
4. Dr. Loic Barbot, dr. Damien Fourmentel, dr. Christian Jammes, CEA, Cadarache, France, 13. 5.–17. 5. 2013
5. Dr. Andreas Fristedt Åblad, Westinghouse, Sweden, 18. 6. 2013
6. Dr. Angelgiorgio Iorizzo, Mark Cosyns, European Commission, Brussels, Belgium, 21. 6. 2013
7. Dr. Igor Remec, Oak Ridge National Laboratory, Reactor and Nuclear Systems Division, Radiation Transport Group, Oak Ridge, TN, USA, 18. 11.–22. 11. 2013
8. Elchin Huseynov, Institute of Radiation Problems of ANAS, Republican Nuclear and Radiation Safety Centre, Baku, Azerbaijan, 1. 12.–22. 12. 2013

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 18. Bojan Zefran

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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Jiří Adámek, M. Peterka, Tomaž Gyergyek, Pavel Kudrna, M. Ramisch, U. Stroth, J. Cavalier, Milan Tichý, "Application of the ball-pen probe in two low-temperature magnetised plasma devices and in torsatron TJ-K", In: 9th International Workshop on Electric Probes in Magnetized Plasmas, September 21-23, 2011, Iași, Romania, *Contrib. Plasma Phys.*, vol. 53, no. 1, pp. 39-44, 2013.
2. JET EFDA Contributors, M. P. Albuquerque *et al.*, "A 10000-image-per-second parallel algorithm for real-time detection of MARFES on JET", *IEEE trans. plasma sci.*, iss. 2, vol. 41, pp. 341-349, 2013.
3. JET EFDA Contributors, B. Baiocchi *et al.*, "Discriminating the role of rotation and its gradient in determining ion stiffness mitigation in JET", *Plasma phys. control. fusion*, iss. 2, vol. 55, pp. 025010-1-025010-7, 2013.
4. Tyler J. Bradshaw, Stephen R. Bowen, Ngoneh Jallow, Lisa J. Forrest, Robert Jeraj, "Heterogeneity in intratumor correlations of ^{18}F – FDG, ^{18}F – FLT, and ^{64}Cu – ATSPET in canine sinonasal tumor", *J Nucl Med (1978)*, vol. 54, no. 11, str. 1931-1937, 2013.
5. JET EFDA Contributors, B. Cannas *et al.*, "Manifold learning to interpret JET high-dimensional operational space", *Plasma phys. control. fusion*, no. 4, vol. 55, pp. 045006-1-045006-11, 2013.
6. C. J. Diez, A. Stankovsky, E. Malambu, Gašper Žerovnik, P. Schillebeeckx, G. Van den Eynde, J. Heyse, C. Cabellos, "Review of the $^{nat}\text{C}(n,\gamma)$ cross section and criticality calculations of the graphite moderated reactor BR1", *Ann. nucl. energy*, vol. 60, pp. 210-217, 2013.
7. JET EFDA Contributors, D. Dodt *et al.*, "Improved framework for the maintenance of the JET intershot analysis chain", *Fusion eng. des.*, vol. 88, no. 2, pp. 79-84, 2013.
8. JET EFDA Contributors, J. Eriksson *et al.*, "Finite Larmor radii effects in fast ion measurements with neutron emission spectrometry", *Plasma phys. control. fusion*, iss. 1, vol. 55, pp. 015008-1-015008-9, 2013.
9. Johannes Gruenwald, D. Tskhakaya, Jernej Kovačič, Milan Čerček, Tomaž Gyergyek, C. Ionita, Roman Schrittwieser, "Comparison of measured and simulated electron energy distribution functions in low-pressure helium plasmas", *Plasma sources sci. technol.*, vol. 22, no. 1, pp. 1-7, Feb. 2013.
10. Tomaž Gyergyek, Jernej Kovačič, "Potential formation in a bounded plasma system which is terminated by an electron emitting floating collector studied by a particle-in-cell computer simulation", *Contrib. Plasma Phys. (1988)*, vol. 53, no. 3, pp. 189-201, 2013.
11. JET EFDA Contributors, G. Hommen *et al.*, "A fast, magnetics-free flux surface estimation and q-profile reconstruction algorithm for feedback control of plasma profiles", *Plasma phys. control. fusion*, iss. 2, vol. 55, pp. 025007-1-025007-11, 2013.
12. Anže Jazbec, Gašper Žerovnik, Luka Snoj, Andrej Trkov, "Analysis of tritium production in TRIGA Mark II reactor at JSI for the needs of fusion research reactors", *Atw, Int. Z. Kernenerg.*, iss. 12, vol. 58, pp. 701-705, 2013.
13. Ivan Aleksander Kodeli, "Sensitivity and uncertainty in the effective delayed neutron fraction (β_{eff})", *Nucl. instrum. methods phys. res., Sect. A, Accel.*, vol. 715, pp. 70-78, 2013.
14. Marjan Kromar, Bojan Kurinčič, "Impact of stainless steel guide tubes on the reactivity parameters of the NPP Krško core", *Journal of energy technology*, iss. 4, vol. 6, str. 75-82, 2013.
15. JET EFDA Contributors, K.D. Lawson *et al.*, "The effect of ionization on the populations of excited levels of C IV and C V in tokamak edge plasmas", *J. phys., B At. mol. opt. phys.*, vol. 46, no. 3, pp. 035701-1-035701-18, 2013.
16. Igor Lengar, Luka Snoj, "Benchmark evaluation of interacting aluminum cylinders containing uranyl fluoride solution", In: Special section NENE 2011, 20th international conference "Nuclear Energy for New Europe" (NENE 2011), Bovec, Slovenija, Sept. 12. - 15. 2011, *Nucl. Eng. Des.*, vol. 261, pp. 232-237, 2013.
17. JET EFDA Contributors, M. J. Lopez *et al.*, "Integration and validation of a disruption predictor simulator in JET", *Fusion science and technology*, iss. 1, vol. 63, pp. 26-33, 2013.
18. C. Morrison, Robert Jeraj, G. Liu, "Imaging of castration-resistant prostate cancer: development of imaging response biomarkers", *Curr Opin Urol*, vol. 23, 3, pp. 230-236, 2013.
19. M. T. Munley, G. C. Kagadis, Kiaran P. McGee, Asen S. Kirov, Sunyoung Jang, Sasa Mutić, Robert Jeraj, Lei Xing, J. D. Bourland, "An introduction to molecular imaging in radiation oncology: a report by the AAPM Working Group on Molecular Imaging in Radiation Oncology (WGMIR)", *Med. phys. (Lanc.)*, vol. 40, no. 10, str. 1188-1194, 2013.
20. Tsviatko K. Popov, Mladen Mitov, Ana Bankova, Pavlina Ivanova, Miglena Dimitrova, Sebastijan Rupnik, Jernej Kovačič, Tomaž Gyergyek, Milan Čerček, F. M. Dias, "Langmuir probe method for precise evaluation of the negative-ion density in electronegative gas discharge magnetized plasma", In: Proceedings of contributed papers, 9th International Workshop on Electric Probes in Magnetized Plasmas,

- September 21-23, 2011, *Contrib. Plasma Phys.*, vol. 53, no. 1, pp. 51-56, 2013.
21. Vladimir Radulović, Andrej Trkov, Radojko Jačimović, Robert Jeraj, "Measurement of the neutron activation constants Q_0 and k_0 for the $^{27}\text{Al}(n, \gamma)^{28}\text{Al}$ reaction at the JSI TRIGA Mark II reactor", *J. radioanal. nucl. chem.*, no. 3, vol. 298, pp. 1791-1800, 2013.
 22. D. De Ruyscher *et al.* (11 authors), "Quantification of radiation-induced lung damage with CT scans: the possible benefit for radiogenomics", *Acta oncol. (Stockh.)*, vol. 52, no. 7, pp. 1405-1410, 2013.
 23. JET EFDA Contributors, C. Silva *et al.*, "Observation of geodesic acoustic modes in the JET edge plasma", *Plasma phys. control. fusion*, iss. 2, vol. 55, pp. 025001-1-025001-6, 2013.
 24. JET EFDA Contributors, Luka Snoj *et al.*, "Calculations to support JET neutron yield calibration: Modelling of the JET remote handling system", *Nucl. Eng. Des.*, vol. 261, pp. 244-250, 2013.
 25. M. Vanderhoeck, S. B. Perlman, Robert Jeraj, "Impact of different standardized uptake value measures on PET-based quantification of treatment response", *J Nucl Med (1978)*, vol. 54, no. 8, pp. 1188-1194, 2013.
 26. Gašper Žerovnik, R. Capote, Andrej Trkov, "On random sampling of correlated resonance parameters with large uncertainties", *Nucl. instrum. methods phys res, Sect. A, Accel.*, vol. 723, pp. 89-98, 2013.
 27. Gašper Žerovnik, Andrej Trkov, Donald L. Smith, R. Capote, "Transformation of correlation coefficients between normal and lognormal distribution and implications for nuclear applications", *Nucl. instrum. methods phys res, Sect. A, Accel.*, vol. 727, pp. 33-39, 2013.
- simulations in support of probe measurements of COMPASS scrape-off-layer", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 1-6.
6. D.B. Syme, Sergei Popovichev, S. Conroy, Igor Lengar, Luka Snoj, Benjamin Choyce Sowden, L. Giacomelli, G. Hermon, D. Plummer, J. Stephens, P. Batistoni, R. Prokopowitz, S. Jednorog, R. Abhangi, R. Makwana, "JET neutron calibration 2013", In: *Proceedings, 8th Workshop on Fusion Data Processing, Validation and Analysis* November 4-6, 2013, Ghent, Ghent, Universiteit Gent, 2013.
 7. Andrej Trkov, Luka Snoj, Gašper Žerovnik, "Feasibility study and installation of thermal neutron driven 14 MeV neutron converter into the TRIGA research reactor", In: *Application of research reactors towards research on materials for nuclear fusion technology*, (IAEA TECDOC, 1724), Vienna, IAEA, 2013, pp. 109-114.

PROFESSIONAL MONOGRAPH

1. John D. Bess, Barbara Dolphin, James W. Sterbentz, Luka Snoj, Igor Lengar, O. Köberl, Jordan Kelly, *HTR-Proteus pebble bed experimental program Cores 1, 1A, 2, and 3: Hexagonal close packing with a 1:2 moderator-to-fuel pebble ratio*, (INL/EXT, 11-23219), Idaho Falls, Idaho National Laboratory, 2013.
2. John D. Bess, James W. Sterbentz, Luka Snoj, Igor Lengar, O. Köberl, *HTR-Proteus pebble bed experimental program Cores 5, 6, 7 & 8: Columnar hexagonal point-on-point packing with a 1:2 moderator-to-fuel pebble ratio*, (INL/EXT, 12-26585), Idaho Falls, Idaho National Laboratory, 2013.
3. John D. Bess, James W. Sterbentz, Luka Snoj, Igor Lengar, O. Köberl, *HTR-Proteus pebble bed experimental program Cores 9 & 10: Columnar hexagonal point-on-point packing with a 1:1 moderator-to-fuel pebble ratio*, (INL/EXT, 12-26334), Idaho Falls, Idaho National Laboratory, 2013.
4. A.J. Koning *et al.*, *Validation of the JEFF-3.1 Nuclear Data Library*, (JEFF Report, 23), Paris, OECD Nuclear Energy Agency, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Tomaž Gyergyek, Jernej Kovačič, Nikola Jelić, "Particle-in-cell simulation of the potential formation in a bounded plasma system at small potential difference between the plasma and the bounding electrode", In: *Zbornik dvaindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2013, 16.-18. september 2013, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2013, zv. A, pp. 149-152.
2. Tomaž Gyergyek, Jernej Kovačič, Nikola Jelić, Leon Kos, "Sheath formation in front of a negative electrode close to plasma potential studied by PIC simulations", In: *Proceedings, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems*, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 115-120.
3. Anže Jazbec, Luka Snoj, Borut Smodiš, Andrej Lešnjak, "Periodic safety review of JSI TRIGA Mark II and inspection of the reactor", In: *Proceedings, Joint IGORR 2013 & IAEA technical meeting*, October 13-18, 2013, Daejeon, Daejeon, 2013, 6 pp.
4. Nikola Jelić, Leon Kos, Janez Krek, Jernej Kovačič, Tomaž Gyergyek, A. J. Christlieb, John P. Verboncoeur, "Ionization front in a gas-filled diode during electrical breakdown", In: *Proceedings, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems*, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 109-114.
5. Jernej Kovačič, Tsviatko K. Popov, Miglena Dimitrova, Tomaž Gyergyek, Milan Čerček, Renaud Dejarnac, Jan Stöckel, Radomir Panek, "Kinetic

MENTORING

1. Jernej Kovačič, *Studying potential formation in front of a negative electrode in fusion relevant plasmas*: doctoral dissertation, Ljubljana, 2013 (mentor Tomaž Gyergyek).
2. Maria Pusa, *Numerical methods for nuclear fuel burnup calculations*: doctoral dissertation, Aalto, 2013 (mentor Olavi Nevanlinna; co-mentors Jaakko Leppänen, Ivan Aleksander Kodeli in Jukka Tuomela).
3. Vladimir Radulović, *Validacija jedrskih presekov z uporabo aktivacijske metode moduliranih nevtronskih spektrov na reaktorju TRIGA*: doctoral dissertation, Ljubljana, 2013 (mentor Robert Jeraj; co-mentor Andrej Trkov).
4. Pouya Sabouri, *Application of perturbation theory methods to nuclear data uncertainty propagation using the collision probability method*: doctoral dissertation, Grenoble, 2013 (mentor Ivan Aleksander Kodeli).
5. Damijan Valentinuzzi, *Modeling tumor response to targeted therapy with anti-angiogenic drugs*: master's thesis, Ljubljana, 2013 (mentor Robert Jeraj; co-mentor Urban Simončič).

DEPARTMENT OF EXPERIMENTAL PARTICLE PHYSICS

F-9

Departmental research is devoted to experimental studies of elementary particles in order to reveal the ultimate building blocks of matter and the nature of the interactions between them. Experiments are carried out within large collaborative programmes at international centres for particle physics at CERN near Geneva and at KEK in Tsukuba. The department is also engaged in developing and applying the technologically advanced particle detectors that are demanded by such measurements. Astroparticle physics is an emerging field, applying the experimental techniques of particle physics to solve astrophysical problems. Slovenian researchers are participating in measurements of ultra-high-energy cosmic rays with the Pierre Auger observatory spread over a surface of 3000 km² near Malargue in Argentina.



Head:
Prof. Marko Mikuž

In order to reveal the ultimate secrets of nature in the world of elementary particles, accelerators with higher and higher energies are needed. Their cost, both in terms of money and human resources, has grown to the level where they are affordable only as joint international enterprises. Thus, future accelerators will be unique facilities of their kind, the first being the Large Hadron Collider (LHC), just completed at the European Organization for Nuclear Research (CERN) near Geneva. Researchers will exploit this facility to perform experiments in presently inaccessible regions of energy, which, though pushed higher and higher, still remains minute compared to that of the vast blast of the Big Bang that led to the creation of the Universe.

Together with colleagues from the Physics Department of the Faculty of Mathematics and Physics and the Faculty of Electrical Engineering of the University of Ljubljana, and from the Faculty of Chemistry and Chemical Technology of the University of Maribor, we are performing measurements at CERN and the Japanese centre KEK in Tsukuba. We are taking part in two experiments, each conducted as an international collaboration:

- ATLAS at the Large Hadron Collider (LHC) at CERN (3000 researchers, 174 institutions from 38 countries),
- Belle at the asymmetric electron-positron collider (KEK-B) at KEK (409 researchers, 62 institutions from 15 countries)

In the field of astroparticle physics we are part of the Pierre Auger collaboration (250 researchers, 94 institutions from 17 countries), which uses a giant scale (3000 km²) observatory near Malargue in Argentina for the detection of ultra-high-energy cosmic rays. This endeavour is carried out in collaboration with colleagues from the University of Nova Gorica.

A more detailed report on our 2012 activities follows, focused on the contributions of our researchers:

ATLAS experiment

The amount of data delivered by the Large Hadron Collider (LHC) at CERN in 2011 and 2012 exceeded the most optimistic expectations and the analysis of the data is occupying the scientists of the ATLAS collaboration throughout 2013 as well as 2014. In addition to the analysis of the existing data the collaboration is preparing for the re-start of the Large Hadron Collider LHC in the year 2015, when it will begin to operate at the unprecedented centre-of-mass energy of 13 TeV.

A Slovenian group of ten scientists worked together with around 3000 colleagues in the ATLAS collaboration. A vast number of physical data analyses were made using global network Grid technology, in which the Slovenian capacities contributed a few percent of the data processing.

The new particle, the discovery of which was announced at the seminar held on 4th of July 2012, was in 2013 confirmed to be the long-sought Higgs boson by measuring the particle properties (e.g., spin and parity). As a consequence of this discovery (Fig. 1) by the collaborations ATLAS and CMS the Nobel prize for Physics was in 2013 given for the theoretical prediction of the

The discovery of the Higgs boson by the ATLAS and CMS collaborations is the reason for the Nobel Prize given for Physics in 2013.



Figure 1.: The 2013 European Physical Society's High Energy and Particle Physics Prize, for an outstanding contribution to high-energy physics was awarded to the ATLAS and CMS collaborations "For the discovery of a Higgs boson, as predicted by the Brout-Englert-Higgs mechanism". (From left) Joe Incandela, Peter Higgs, Francois Englert, Tejinder Virdee, Dave Charlton (ATLAS), and Peter Jenni (ATLAS).

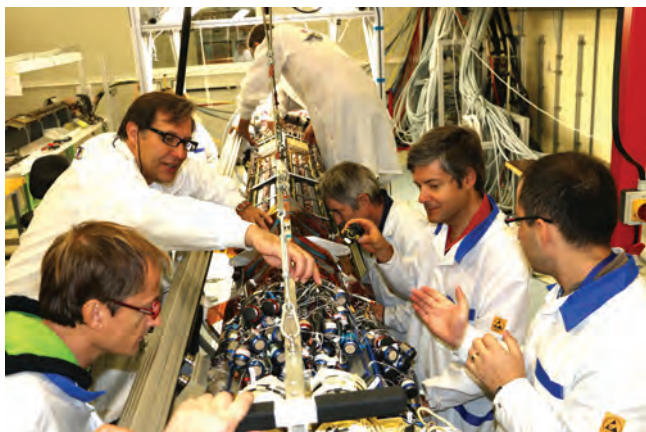


Figure 2.: Assembly of the new diamond detector DBM (Diamond Beam Monitor) of ATLAS. It will provide precise online measurements of the bunch luminosities at the LHC.

Higgs boson to P. Higgs and F. Englert and the prize itself cites the discovery of the Higgs boson by the ATLAS and CMS collaborations. The news about the discovery of the Higgs boson was published in practically all the world's media. This result is an important advance in our understanding of the basic forces holding the Universe together. In particular this new boson provides support for the existence of the proposed Higgs field, which explains how some particles come to have a mass and others do not. Without mass, all particles would fly around freely and matter as we know it would not exist. Physicists work to a theory of fundamental particles and their interactions called the Standard Model, which was first proposed in the 1970s. So far experiments have been able to confirm the existence of nearly all its elements with a high degree of precision. The Higgs boson, however, had eluded detection until now, prompting speculation that the theory could be incomplete. The findings so far suggest a Higgs boson compatible with the Standard Model, but further studies are needed to confirm this. We are looking for more Higgs particles, which according to almost all the high-energy extensions of the Standard Model, should exist. Some of the most popular new

models of physics are the so-called Super-symmetry theories, which could potentially solve a number of problems in theoretical physics. The most minimalist Super-symmetry theory predicts at least five (!) Higgs bosons: three neutral and two charged. So in the future, if we detect more than one, we will know that we are looking at a new physics. Searches for beyond-Standard-Model physics continued throughout 2013 and while a plethora of possible theories were statistically excluded, no discoveries of New Physics were as yet made. There are however good indications that such discoveries could be made when the LHC restarts in 2015 at the even higher energies.

A group of researchers from our department had one of the leading roles in the development, implementation and operation of two charged particle detector systems in the centre of the ATLAS spectrometer. Both systems, the Beam Conditions Monitor (BCM) and Beam Loss Monitor (BLM), are based on pCVD diamond sensors. The BCM is much more complex and has several functionalities. One task is monitoring the conditions of the LHC (Large Hadron Collider) proton beams at the interaction point in the centre of ATLAS spectrometer and issuing warnings at potential dangers. The BCM was the main luminosity monitor of the ATLAS experiment throughout most of the data-taking period of 2011 and 2012, when ATLAS was delivered about 30 fb⁻¹ of data. In the second half of 2012 the BCM was enabled and was active in the Beam Interlock System and could have triggered a beam abort if the thresholds were reached.

The BLM is a much simpler system, the aim of which is the protection of the Inner Detector of ATLAS against potentially dangerous beam conditions. In summer 2011 the BLM twice triggered a LHC beam dump and prevented potential damage in the delicate silicon detectors of the Inner Detector.

Our group also developed and maintained the RADMON system that is used for recording the radiation doses due to charged particles and neutrons that different parts of the Inner Detector receive.

In 2013 the upgrade of the Large Hadron Collider started that will last for two years. During this period the LHC is being consolidated to be ready to operate at higher proton energy and higher luminosity. The ATLAS spectrometer is also being upgraded to be able to cope with a higher collision pileup. One of the most important upgrades is the

installation of an additional layer of silicon detectors for improved tracking and vertexing. A set of telescopes built on the basis of the same readout chip as used for the additional silicon layer and mostly using pCVD diamonds for the sensor material (Diamond Beam Monitor, DBM) is being installed and commissioned with a strong participation of the Ljubljana group. In 2013 the detectors were assembled, tested and installed into the final position in the centre of ATLAS. Currently, the works continue with a final connection and the development of firmware and software for the readout of data and the data acquisition.

The Belle collaboration performed a series of measurements of rare processes that constrain the parameter space of several new physics models. Specifically, we measured parameters describing the difference between particles and antiparticles in processes with a significant quantum loops' contribution

Belle detector at the asymmetric electron-positron collider KEKB at KEK

The Belle detector at the electron-positron collider KEKB in Tsukuba, Japan, stopped taking data in 2010 in order to make room for an upgraded version of the detector. The new detector, Belle II, will begin operation in 2015. Meanwhile, the data collected by the Belle detector are still being used for a series of very interesting measurements. The main purpose of these measurements is a search for previously unknown particles and processes that are known as the New Physics. Among other things, such processes are responsible for the fact that we live in a Universe in which matter (particles) completely dominates over antimatter (antiparticles).

One of the most interesting ways to find signals of the New Physics are decays in which a b quark from a B meson transforms into an s quark (as for example in the decay $B \rightarrow \eta' K_s$). This type of decay proceeds through the so-called “quantum fluctuations”, where the b quark turns for very short period of time into a much heavier t quark and W boson, and then ends up as an s quark, together with a pair of a quark and an anti-quark. Instead of the t quark and the W boson new types of particles could show up in such a process that are not part of the Standard Model, and have not been discovered up to now. Such a hidden presence of new particles could change the values of the two parameters S and A of CP violation in the process under study, so that they would differ significantly from the values as determined in the decay $B \rightarrow J/\psi K_s$, which cannot be influenced by quantum fluctuations. The experimental study of $B \rightarrow \eta' K_s$ (a topic of the PhD Thesis of Luka Šantelj) has shown (Figure 3) that the parameters of CP violation are consistent with the value of these two parameters in the decay $B \rightarrow J/\psi K_s$. This means that while the effects of New Physics in this decay channel cannot be excluded, they must be quite small; this conclusion represents one of the most important results of the Belle Collaboration in 2013. Slovenian physicists have also led a study where a new method was developed and applied to measure for the first time the absolute probability of a decay of a charmed baryon Λ_c to a proton, a kaon and a pion. A precise value of this probability is required as an input in the interpretation of several other measurements, such as the exclusive and inclusive decay-rate measurements of b-flavored mesons and baryons or the measurements of fragmentation fractions of charm and bottom quarks. Another important result is a measurement of mixing in the system of neutral D mesons, as observed in the D meson decays into a kaon-pion pair.

In 2013, we continued with the preparation of the Belle II detector system. In this project, which includes almost 500 physicists from around the world, Slovenian colleagues play a key role, both in the management of the research group, as well as in developing new detection methods and methods for the analysis of the collected data.

Pierre Auger observatory

The Earth is exposed to a permanent rain of cosmic particles from outer space. Most of the particles are fully ionized atomic nuclei, moving with relativistic energies. The bulk of them with energies up to 10^{17} eV originate within our Milky Way. They are most likely accelerated in supernova remnants. Some particles have a thousand times higher energies, *i.e.*, around 10^{20} eV. To clarify the origin of the highest-energy particles, their properties, like energy, arrival direction and the particle type (photons, protons, atomic nuclei), have to be measured. The highest-energy cosmic rays are extremely rare. On Earth one particle is registered in an area of 100 square kilometres in a hundred years. The measurement of such particles requires a huge measurement device that is operated for a long time.

The Pierre Auger Observatory combines two complementary techniques to measure air showers. On their way through the atmosphere the secondary particles stimulate nitrogen molecules in the air to emit fluorescence light. This light is measured with large telescopes. In addition, secondary particles reaching ground level are registered in an array of particle detectors. The latter are water Cherenkov detectors, measuring the light emitted by relativistic particles passing through a water tank. The Pierre Auger Observatory is the largest-aperture cosmic-ray observatory at present, built to reach large statistics for the low flux of Ultra High Energy Cosmic Rays (UHECR). Constructed in the province of Mendoza, Argentina, the observatory is the first hybrid air-shower experiment combining two independent observation techniques. It consists of 1660 water Cherenkov stations with a 1.5-km spacing on a triangular grid (the surface detector, SD), overlooked by 24 fluorescence telescopes housed in four buildings (fluorescence detector, FD). It covers an area of 3000 square kilometres of Pampa and has a hexagonal footprint with a diameter of about 60 kilometres.

Above 10^9 eV, the cosmic ray flux falls with energy E roughly as $E^{-\gamma}$ where the spectral index $\gamma \sim 3$. Several breaks in the spectral index have been observed, reflecting cosmic ray properties like the interaction between particles and the photons of the 3K microwave background at 4×10^{18} eV and a fall-off at energies exceeding 10^{19} eV due to cosmic acceleration processes being proportional to the magnetic field in the astrophysical sources. Due to growing statistics every year an updated measurement of the energy spectrum is published. At an exposure of $5400 \text{ km}^2 \times \text{sr} \times \text{year}$ a suppression with $\gamma_1 = 2.59 \pm 0.02$, $\gamma_2 = 4.3 \pm 0.02$ and $\gamma_3 = 4.3 \pm 0.02$ was observed.

The identification of the type of the impinging cosmic-ray particle is experimentally the biggest challenge. Incoming particles such as atomic nuclei (of different masses), photons, and neutrinos induce cascades in the atmosphere. The longitudinal development of the showers depends on the particle type. Heavy nuclei interact early in the atmosphere, while light particles penetrate much deeper. This implies that for heavy nuclei the whole

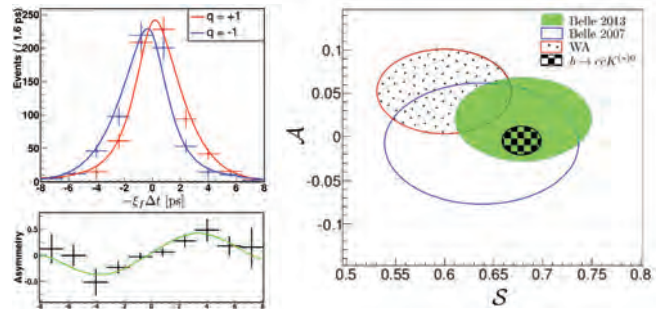


Figure 3: CP violation measurement in $B \rightarrow \eta' K_s$ decays. Left: measured time evolution for B meson (blue) and antimeson (red) decays; the lower plot shows the time evolution of the asymmetry between the two decays. Right: measured value of the two CP violation parameters A and C (green) as compared to the world average in $B \rightarrow \eta' K_s$ decays (oval with a red boundary), previous Belle measurement (oval with a blue boundary) and with the value of both parameters as determined in the $B \rightarrow J/\psi K_s$ decays (chess board).

shower development takes place higher up in the atmosphere as compared to light particles. Thus, a measurement of the height of the shower above the ground is a good estimate for the mass of the primary particle. Technically, we measure the distance between the detector and the position at which the shower contains its maximum number of particles. The investigations indicate that cosmic rays are composed of light particles (such as protons and helium nuclei) at energies around 10^{18} eV. The data exhibit a trend towards heavier nuclei with increasing energy. At energies around 4×10^{19} eV, shower properties consistent with a heavy elemental composition (*e.g.*, silicon or iron nuclei) are observed. At higher energies, at present, no mass measurement is available due to the small flux of particles at such energies. These mass measurements do assume that we can correctly extrapolate hadronic physics from accelerator experiments.

Searches for evidence of photons in the Auger event sets have resulted in no candidates. On the basis of this it is estimated that no more than a few percent of all incident UHE messengers can be photons up to 30 EeV, with a weaker constraint at higher energies.

Given that the highest energy cosmic rays observed should exhibit trajectories that are relatively unperturbed by galactic and intergalactic magnetic fields, it is natural to wonder whether isotropy begins to emerge at these high energies. Furthermore, if the observed flux suppression is the GZK effect, there is necessarily some distance, (100 Mpc), beyond which cosmic rays with energies near 10^{20} eV would not be seen. Since the matter density within about 100 Mpc is not isotropic, this compounds the potential for anisotropy to emerge in the UHECR sample. The Auger Observatory provides two complementary approaches to determine the direction of an incoming cosmic ray. Stereo observations of the showers with multiple fluorescence telescopes provide a three-dimensional picture of the shower in the atmosphere and, thus, the orientation of the shower axis, pointing back into the direction of the incoming particle. Secondly, the measurement of the arrival times of the individual particles at the surface detectors allows us to measure the shower disc, with the arrival direction being perpendicular to it. Based on the Auger data set, 28 out of 84 events with energies higher than 5.6×10^{19} eV were found to be correlated with objects in the Veron-Cetty catalogue of active galactic nuclei. The overall correlation strength thus decreased from $62 \pm 10\%$ previously published to $33 \pm 5\%$. However, the chance probability of observing such a correlation from a random distribution remains below 1%. Correlations on such a small angular scale as those reported (3.1°) would seem to be at odds with the apparent trend for a heavy composition at high energy, since heavier nuclei would be more deflected by intergalactic and galactic magnetic fields.

Distributed computing

SiNET Tier-2 distributed computing site has increased its capacity to 2800 cores and 1200TB of data storage space in the year 2013. As a constitutive member of the Slovenian National Grid Initiative SLING/NGI the site had supported and maintained the Slovenian grid infrastructure together with Arnes. The Slovenian distributed infrastructure incorporates seven clusters from Jožef Stefan Institute, Arnes, Acrtur, University of Nova Gorica, and several others are in the process of joining, with a vision to create a powerful distributed computing infrastructure in Slovenia. The SiNET is a full member of international organizations EGI/InSPIRE, wLCG and Nordugrid and had participated in several joint projects related to the support, maintenance and planning of the computing infrastructure as well as the development, distribution and deployment of the distributed computing infrastructure. It participated in education at several distributed computing workshops organized at Arnes and the Jožef Stefan

Institute. The main objective of SiNET Tier-2 is to support the data processing and storage for the international experiments ATLAS, Belle, Belle 2, and Pierre Auger. In addition, the site provides support to Slovenian research and educational organizations.

Detector development

In 2013, we continued with the development of new methods for the detection of annihilation gamma rays in positron emission tomography (PET), one of the most important medical imaging methods. If a Cherenkov radiator is used as a gamma-ray converter instead of a scintillator, the difference in the time of flight of the two gamma rays can be measured with a very high precision of 80ps (FWHM). In this way we can directly obtain three-dimensional information on the emission point of the two gamma rays, which substantially reduces the time needed to determine the activity distribution in the patient [4]. We have also developed a new method for the detection of gamma rays with a scintillator in which the depth of the gamma-ray conversion within the crystal is determined from a ratio of signal

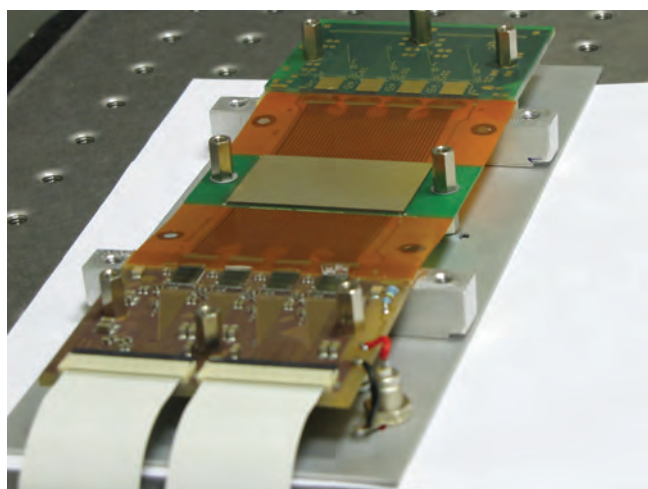


Figure 4: Silicon module assembled with direct bonding of the sensor to the circuit.

intensities in the neighbouring detector pixels. In 2013, a review article on photon detection was published Annual Review of Nuclear and Particle Science.

We developed a rigid flex circuit bound with a compact silicon sensor (by Hamamatsu Photonics) and readout electronics (by IDEAS, Oslo). The design of the circuit and the binding procedure were developed at our department within the Research Voucher program on behalf of the Elgoline, d.o.o. company from Cerknica (Fig. 4). Measurements with a calibration ^{241}Am radioactive source showed that the innovative binding scheme had no effect on the system performance. Such a scheme can be critical in applications where the dense packing of detectors is required as in a setup to measure the interactions of gamma rays in nuclear medicine

In 2011 and 2012 we collected a substantial collection of PET probe data, which offers the possibility to study the effects of the spatial resolution of the sensors on the image quality. For a precise analysis a physical model of the image generation procedure had to be developed along with a model-based reconstruction method of the collected data. With data from the collection we were able to confirm the model validity and the model will be used in the planning of new imaging methods and their impact on diagnostic procedures and treatment.

Development of radiation hard silicon detectors is very important for future high-energy experiments. We used an innovative edge-TCT method, developed at our laboratory, to measure the electric field in silicon detectors. The detectors were irradiated at nuclear reactor in Podgorica near Ljubljana with neutrons up to fluences of $5 \times 10^6 \text{ cm}^{-2}$. Sensors with slim edges allow dense packing with a small loss of efficiency. The efficiencies of sensors with SCP (Scribe Cleave Passivate) edges were measured with laser light

We performed more than 100 irradiations at Nuclear Reactor Podgorica in the framework of AIDA (Advanced European Infrastructures or Detectors at Accelerators) for 15 interested institutions. In the second year of this project the emphasis was on upgrades for the ATLAS, CMS and BELLE detectors.

Organization of conferences, congresses and meetings

1. Meeting of users and administrators and network computing of Slovenian network for national GRID infrastructure, Jožef Stefan Institute, Reactor Center in Podgorica, Podgorica, Slovenia, 13. 11. 2013

INTERNATIONAL PROJECTS

1. Design, Procurement and QA of Flex-rigid Hybrids
European Organization for Nuclear Research
Prof. Marko Mikuž
2. 7FP - EGI-InSPIRE; European Grid Initiative: Integrated Sustainable Pan-European Infrastructure for Researchers in Europe
European Commission
Prof. Marko Mikuž
3. 7FP - AIDA; Advanced European Infrastructures for Detectors at Accelerators
European Commission
Prof. Marko Mikuž
4. 7FP - HadronPhysics3; Study of Strongly Interacting Matter
European Commission
Prof. Samo Korpar
5. FERRO-PATCH; Frequency and Polarisation Agile Microstrip Patch Antenna based on Ferrelectric Varactors
ESA/ESTEC.
Prof. Vladimir Cindro
6. Development of Silicon and Diamond Semiconductor Detectors for Particle Physics Experiments and Medical Imaging
Slovenian Research Agency
Dr. Andrej Gorišek
7. Doping of Semiconductor Nanocrystals by Neutron Transmutation Method (NTD)
Slovenian Research Agency
Asst. Prof. Igor Mandić
8. Evaluation of the Prototype of a Double-ring PET Device
Slovenian Research Agency
Prof. Marko Mikuž
9. Development and Tests of a Method for Particle Identification with a TOP Counter
Slovenian Research Agency
Prof. Marko Starič
10. Methods and Accuracies of the Mixing and CP Violation Measurements of the Charmed Hadrons at the Belle II Experiment
Slovenian Research Agency
Prof. Boštjan Golob

RESEARCH PROGRAMS

1. Astroparticle Physics
Prof. Marko Zavrtanik
2. Experimental Particle Physics
Prof. Marko Mikuž

R&D GRANTS AND CONTRACTS

1. ATLAS Diamond Beam Monitor
Prof. Marko Mikuž
2. Search for Microscopic Black Hole Signatures with Ultra-high Energy Cosmic Rays
Prof. Marko Zavrtanik
3. Development of Solid State Detectors for Particle Physics Experiments
4. Prof. Vladimir Cindro
5. Novel Detection Methods based on Cherenkov Radiation
Prof. Peter Križan
6. Development of In-vivo Dosimetry for Applications in Radiotherapy
Dr. Gregor Kramberger
7. Measurement of the Absolute Branching Fractions of Leptonic D(s) Decays and the Extraction of the Decay Constant $f_{D(s)}$
Dr. Anže Zupanc
8. Collaboration CERN RD-39
Prof. Marko Mikuž
9. Collaboration CERN RD-50
Prof. Marko Mikuž
10. Collaboration DELPHI
Prof. Borut Paul Kerševan
11. Collaboration ATLAS
Prof. Marko Mikuž
12. Collaboration CERN RD-42
Prof. Marko Mikuž
13. Collaborations Belle in Belle II
Prof. Peter Križan
14. Collaboration CLIMA; Cameras for Imaging in Medical Applications
Prof. Marko Mikuž

NEW CONTRACTS

1. Reliability Investigation of High Density Interconnect Circuits
INTEC TIV, d. o. o.
Prof. Vladimir Cindro
2. Data-Storage System
Kenya, d. o. o.
Prof. Andrej Filipčič
3. HPC Puppet
Arctur, d. o. o.
Prof. Andrej Filipčič

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2. Dr. Ivana Čapan, Institut Ruder Bošković, Zagreb, Croatia, 4. 4.-6. 4. 2013
3. Prof. Dr. Neal C. Clinthorne, University of Michigan, USA, 19. 5.-23. 5. 2013
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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. ATLAS Collaboration, G. Aad *et al.*, "ATLAS search for new phenomena in dijet mass and angular distributions using pp collisions at $\sqrt{s} = 7$ TeV", *J. high energy phys.*, vol. 2013, no. 1, pp. 029-1-029-46, 2013.
2. ATLAS Collaboration, G. Aad *et al.*, "Characterisation and mitigation of beam-induced backgrounds observed in the ATLAS detector during the 2011 proton-proton run", *Journal of instrumentation*, vol. 8, no. 7, pp. P07004-1-P07004-72, 2013.
3. ATLAS Collaboration, G. Aad *et al.*, "Improved luminosity determination in pp collisions at $\sqrt{s} = 7$ TeV using the ATLAS detector at the LHC", *The European physical journal. C*, vol. 73, no. 8, pp. 2518-1-2518-39, 2013.
4. ATLAS Collaboration, G. Aad *et al.*, "Jet energy resolution in proton-proton collisions at $\sqrt{s} = 7$ TeV recorded in 2010 with the ATLAS detector", *The European physical journal. C*, vol. 73, no. 3, pp. 2306-1-2306-27, 2013.
5. ATLAS Collaboration, G. Aad *et al.*, "Measurement of W^+W^- production in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector and limits on anomalous WWZ and $WW\gamma$ couplings", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 87, no. 11, pp. 112001-1-112001-29, 2013.
6. ATLAS Collaboration, G. Aad *et al.*, "Measurement of ZZ production in pp collisions at $\sqrt{s} = 7$ TeV and limits on anomalous ZZZ and $ZZ\gamma$ couplings with the ATLAS detector", *J. high energy phys.*, vol. 2013, no. 3, pp. 128-1-128-48, 2013.
7. ATLAS Collaboration, G. Aad *et al.*, "Measurement of angular correlations in Drell-Yan lepton pairs to probe Z/γ boson transverse momentum at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 720, no. 1/3, pp. 32-51, 2013.
8. ATLAS Collaboration, G. Aad *et al.*, "Measurement of charged-particle event shape variables in inclusive $\sqrt{s} = 7$ TeV proton-proton interactions with the ATLAS detector", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 88, no. 3, pp. 032004-1-032004-25, 2013.
9. ATLAS Collaboration, G. Aad *et al.*, "Measurement of hard double-parton interactions in $W \rightarrow \ell\nu + 2$ -jet events at $\sqrt{s} = 7$ TeV the ATLAS detector", *New journal of physics*, vol. 15, no. 3, pp. 033038-1-033038-39, 2013.
10. ATLAS Collaboration, G. Aad *et al.*, "Measurement of isolated-photon pair production in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *J. high energy phys.*, vol. 2013, no. 1, pp. 086-1-086-42, 2013.
11. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the $t\bar{t}$ production cross section in the $\tau +$ jets channel using the ATLAS detector", *The European physical journal. C*, vol. 73, no. 3, pp. 2328-1-2328-18, 2013.
12. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the Δ_b^0 lifetime and mass in the ATLAS experiment", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 87, issue 3, pp. 032002-1-032002-19, 2013.
13. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the flavour composition of dijet events in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *The European physical journal. C*, vol. 73, no. 2, pp. 2301-1-2301-30, 2013.
14. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the inclusive jet cross-section in pp collisions at $\sqrt{s} = 2.76$ TeV and comparison to the

- inclusive jet cross-section at $\sqrt{s} = 7$ TeV using the ATLAS detector", *The European physical journal. C*, vol. 73, no. 8, pp. 2509-1-2509-56, 2013.
15. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the jet radius and transverse momentum dependence of inclusive jet suppression in leadlead collisions at $\sqrt{s_{NN}} = 2.76$ TeV with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 719, no. 4/5, pp. 220-241, 2013.
 16. ATLAS Collaboration, G. Aad *et al.*, "Measurement of upsilon production in 7 TeV pp collisions at ATLAS", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 87, no. 5, pp. 052004-1-052003-31, 2013.
 17. ATLAS Collaboration, G. Aad *et al.*, "Measurements of top quark pair relative differential cross-sections with ATLAS in pp collisions at $\sqrt{s} = 7$ TeV", *The European physical journal. C*, vol. 73, no. 1, pp. 2261-1-2261-28, 2013.
 18. ATLAS Collaboration, G. Aad *et al.*, "Multi-channel search for squarks and gluinos in $\sqrt{s} = 7$ TeV pp collisions with the ATLAS detector at the LHC", *The European physical journal. C*, vol. 73, no. 3, pp. 2362-1-2362-33, 2013.
 19. ATLAS Collaboration, G. Aad *et al.*, "Observation of associated near-side and away-side long-range correlations in $\sqrt{s_{NN}} = 5.02$ TeV proton-lead collisions with the ATLAS detector", *Phys. Rev. Lett.*, vol. 110, no. 18, pp. 182302-1-182302-18, 2013.
 20. ATLAS Collaboration, G. Aad *et al.*, "Search for a heavy narrow resonance decaying to $e\mu$, $e\tau$, or $\mu\tau$ with the ATLAS detector in $\sqrt{s} = 7$ TeV pp collisions at the LH", *Phys. Lett., Sect. B*, vol. 723, issue 1-3, pp. 15-32, 2013.
 21. ATLAS Collaboration, G. Aad *et al.*, "Search for charged Higgs bosons through the violation of lepton universality in $t\bar{t}$ events using pp collision data at $\sqrt{s} = 7$ TeV with the ATLAS experiment", *J. High Energy Phys.*, vol. 2013, no. 3, pp. 076-1-076-36, 2013.
 22. ATLAS Collaboration, G. Aad *et al.*, "Search for dark matter candidates and large extra dimensions in events with a jet and missing transverse momentum with the ATLAS detector", *J. High Energy Phys.*, vol. 2013, no. 4, pp. 075-1-075-51, 2013.
 23. ATLAS Collaboration, G. Aad *et al.*, "Search for direct chargino production in anomaly-mediated supersymmetry breaking models based on a disappearing-track signature in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *J. High Energy Phys.*, vol. 2013, no. 1, pp. 131-1-131-34, 2013.
 24. ATLAS Collaboration, G. Aad *et al.*, "Search for direct production of charginos and neutralinos in events with three leptons and missing transverse momentum in $\sqrt{s} = 7$ TeV pp collisions with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 718, no. 2, pp. 841-859, 2013.
 25. ATLAS Collaboration, G. Aad *et al.*, "Search for displaced muonic lepton jets from light Higgs boson decay in proton-proton collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 721, no. 1/3, pp. 32-50, 2013.
 26. ATLAS Collaboration, G. Aad *et al.*, "Search for excited electrons and muons in $\sqrt{s} = 8$ TeV proton-proton collisions with the ATLAS detector", *New Journal of Physics*, vol. 15, no. 9, pp. 093011-1-093011-32, 2013.
 27. ATLAS Collaboration, G. Aad *et al.*, "Search for extra dimensions in diphoton events from proton-proton collisions at $\sqrt{s} = 7$ TeV in the ATLAS detector at the LHC", *New Journal of Physics*, vol. 15, no. 4, pp. 043007-1-043007-34, 2013.
 28. ATLAS Collaboration, G. Aad *et al.*, "A search for high-mass resonances decaying to $\tau^+\tau^-$ in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 719, no. 4/5, pp. 242-260, 2013.
 29. ATLAS Collaboration, G. Aad *et al.*, "Search for light top squark pair production in final states with leptons and b -jets with the ATLAS detector in $\sqrt{s} = 7$ TeV proton-proton collisions", *Phys. Lett., Sect. B*, vol. 720, no. 1-3, pp. 13-31, 2013.
 30. ATLAS Collaboration, G. Aad *et al.*, "Search for long-lived, heavy particles in final states with a muon and multi-track displaced vertex in proton-proton collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 719, no. 4/5, pp. 280-298, 2013.
 31. ATLAS Collaboration, G. Aad *et al.*, "Search for long-lived, multi-charged particles in pp collisions at $\sqrt{s} = 7$ TeV using the ATLAS detector", *Phys. Lett., Sect. B*, vol. 722, no. 4/5, pp. 305-323, 2013.
 32. ATLAS Collaboration, G. Aad *et al.*, "Search for new phenomena in events with three charged leptons at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 87, no. 5, pp. 052002-1-052002-33, 2013.
 33. ATLAS Collaboration, G. Aad *et al.*, "Search for nonpointing photons in the diphoton and E_T^{miss} final state in $\sqrt{s} = 7$ TeV proton-proton collisions using the ATLAS detector", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 88, no. 1, pp. 012001-1-012001-24, 2013.
 34. ATLAS Collaboration, G. Aad *et al.*, "Search for pair production of heavy top-like quarks decaying to a high- p_T W boson and a b quark in the lepton plus jets final state at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 718, no. 4/5, pp. 1284-1302, 2013.
 35. ATLAS Collaboration, G. Aad *et al.*, "Search for pair-produced massive coloured scalars in four-jet final states with the ATLAS detector in proton-proton collisions at $\sqrt{s} = 7$ TeV", *The European physical journal. C*, vol. 73, no. 1, pp. 2263-1-2263-20, 2013.
 36. ATLAS Collaboration, G. Aad *et al.*, "A search for prompt lepton-jets in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 719, no. 4/5, pp. 299-317, 2013.
 37. ATLAS Collaboration, G. Aad *et al.*, "Search for resonances decaying into top-quark pairs using fully hadronic decays in pp collisions with ATLAS at $\sqrt{s} = 7$ TeV", *J. High Energy Phys.*, vol. 2013, no. 1, pp. 116-1-116-50, 2013.
 38. ATLAS Collaboration, G. Aad *et al.*, "Search for resonant diboson production in the $WW/WZ \rightarrow \ell\nu jj$ decay channels with the ATLAS detector at $\sqrt{s} = 7$ TeV", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 87, issue 11, pp. 112006-1-112006-22, 2013.
 39. ATLAS Collaboration, G. Aad *et al.*, "Search for single b^* -quark production with the ATLAS detector at $\sqrt{s} = 7$ TeV", *Phys. Lett., Sect. B*, vol. 721, no. 4/5, pp. 171-189, 2013.
 40. ATLAS Collaboration, G. Aad *et al.*, "Search for squarks and gluinos with the ATLAS detector in final states with jets and missing transverse momentum using $4.7fb^{-1}$ of $\sqrt{s} = 7$ TeV proton-proton collision data", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 87, no. 1, pp. 012008-1-012008-34, 2013.
 41. ATLAS Collaboration, G. Aad *et al.*, "Search for supersymmetry in events with photons, bottom quarks, and missing transverse momentum in proton-proton collisions at a centre-of-mass energy of 7 TeV with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 719, issue 4-5, pp. 261-279, 2013.
 42. ATLAS Collaboration, G. Aad *et al.*, "Search for $t\bar{t}$ resonances in the lepton plus jets final state with ATLAS using $4.7fb^{-1}$ of pp collisions at $\sqrt{s} = 7$ TeV", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 88, no. 1, pp. 012004-1-012004-28, 2013.
 43. ATLAS Collaboration, G. Aad *et al.*, "Search for the neutral Higgs bosons of the minimal supersymmetric standard model in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *J. High Energy Phys.*, vol. 2013, no. 2, pp. 095-1-095-27, 2013.
 44. ATLAS Collaboration, G. Aad *et al.*, "Search for WH production with a light Higgs boson decaying to prompt electron-jets in proton-proton collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *New Journal of Physics*, vol. 15, no. 4, pp. 043009-1-043009-35, 2013.
 45. ATLAS Collaboration, G. Aad *et al.*, "Searches for heavy long-lived sleptons and R-hadrons with the ATLAS detector in pp collisions at $\sqrt{s} = 7$ TeV", *Phys. Lett., Sect. B*, vol. 720, no. 4/5, pp. 277-308, 2013.
 46. ATLAS Collaboration, G. Aad *et al.*, "Triggers for displaced decays of long-lived neutral particles in the ATLAS detector", *Journal of Instrumentation*, vol. 8, no. 7, pp. P07015-1-P07015-34, 2013.
 47. ATLAS Collaboration, G. Aad *et al.*, "Dynamics of isolated-photon plus jet production in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Nucl. Phys., Sect. B*, vol. 875, no. 3, pp. 483-535, 2013.
 48. ATLAS Collaboration, G. Aad *et al.*, "Evidence for the spin-0 nature of the Higgs boson using ATLAS data", *Phys. Lett., Sect. B*, vol. 726, no. 1/3, pp. 120-144, 2013.
 49. ATLAS Collaboration, G. Aad *et al.*, "Measurement of k_T splitting scales in $W \rightarrow \ell\nu$ events at $\sqrt{s} = 7$ TeV with the ATLAS detector", *The European physical journal. C*, vol. 73, no. 5, pp. 2432-1-2432-30, 2013.
 50. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the azimuthal angle dependence of inclusive jet yields in Pb + Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV with the ATLAS detector", *Phys. Rev. Lett.*, vol. 111, no. 15, pp. 152301-1-152301-18, 2013.
 51. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the cross-section for W boson production in association with b -jets in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *J. High Energy Phys.*, vol. 2013, no. 6, pp. 084-1-084-45, 2013.
 52. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the differential cross-section of B^+ meson production in pp collisions at $\sqrt{s} = 7$ TeV using the ATLAS detector", *J. High Energy Phys.*, vol. 2013, no. 10, pp. 042-1-042-38, 2013.
 53. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the distributions of event-by-event flow harmonics in lead-lead collisions at $\sqrt{s_{NN}} = 2.76$ TeV with the ATLAS detector at the LHC", *J. High Energy Phys.*, vol. 2013, no. 11, pp. 183-1-183-57, 2013.

54. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the high-mass Drell-Yan differential cross-section in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 725, no. 4/5, pp. 223-242, 2013.
55. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the production cross section of jets in association with a Z boson in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *J. high energy phys.*, vol. 2013, no. 7, pp. 032-032-51, 2013.
56. ATLAS Collaboration, G. Aad *et al.*, "Measurement of the top quark charge in pp collisions at $\sqrt{s} = 7$ TeV using the ATLAS detector", *J. high energy phys.*, vol. 2013, no. 11, pp. 031-1-031-42, 2013.
57. ATLAS Collaboration, G. Aad *et al.*, "Measurement of top quark polarization in top-antitop events from proton-proton collisions at $\sqrt{s} = 7$ TeV using the ATLAS detector", *Phys. Rev. Lett.*, vol. 111, no. 23, pp. 232002-1-232002-19, 2013.
58. ATLAS Collaboration, G. Aad *et al.*, "Measurement with the ATLAS detector of multi-particle azimuthal correlations in $p + Pb$ collisions at $\sqrt{s_{NN}} = 5.02$ TeV", *Phys. Lett., Sect. B*, vol. 725, no. 1/3, pp. 60-78, 2013.
59. ATLAS Collaboration, G. Aad *et al.*, "Measurements of W and Z production in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector at the LHC", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 87, no. 11, pp. 112003-1-112003-40, 2013.
60. ATLAS Collaboration, G. Aad *et al.*, "Measurements of Higgs boson production and couplings in diboson final states with the ATLAS detector at the LHC", *Phys. Lett., Sect. B*, vol. 726, no. 1/3, pp. 88-119, 2013.
61. ATLAS Collaboration, G. Aad *et al.*, "Performance of jet substructure techniques for large- R jets in proton-proton collisions at $\sqrt{s} = 7$ TeV using the ATLAS detector", *J. high energy phys.*, vol. 2013, no. 09, pp. 076-1-076-83, 2013.
62. ATLAS Collaboration, G. Aad *et al.*, "Search for a light charged Higgs boson in the decay channel $H^+ \rightarrow c\bar{s}$ in $t\bar{t}$ events using pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *The European Physical Journal C*, vol. 73, no. 6, pp. 2465-1-2565-20, 2013.
63. ATLAS Collaboration, G. Aad *et al.*, "Search for charginos nearly mass degenerate with the lightest neutralino based on a disappearing-track signature in pp collisions at $\sqrt{s} = 8$ TeV with the ATLAS detector", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 88, no. 11, pp. 112006-1-112006-23, 2013.
64. ATLAS Collaboration, G. Aad *et al.*, "Search for direct third-generation squark pair production in final states with missing transverse momentum and two b -jets in $\sqrt{s} = 8$ TeV pp collisions with the ATLAS detector", *J. high energy phys.*, vol. 2013, no. 10, pp. 189-1-189-40, 2013.
65. ATLAS Collaboration, G. Aad *et al.*, "Search for long-lived stopped R -hadrons decaying out of time with pp collisions using the ATLAS detector", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 88, no. 11, pp. 112003-1-112003-30, 2013.
66. ATLAS Collaboration, G. Aad *et al.*, "Search for new phenomena in final states with large jet multiplicities and missing transverse momentum at $\sqrt{s} = 8$ TeV proton-proton collisions using the ATLAS experiment", *J. high energy phys.*, vol. 2013, no. 10, pp. 130-1-130-50, 2013.
67. ATLAS Collaboration, G. Aad *et al.*, "Search for third generation scalar leptoquarks in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *J. high energy phys.*, vol. 2013, no. 6, pp. 033-1-033-40, 2013.
68. ATLAS Collaboration, G. Aad *et al.*, "Measurement of Z boson production in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV with the ATLAS detector", *Phys. Rev. Lett.*, vol. 110, no. 2, pp. 022301-022301-18, 2013.
69. ATLAS Collaboration, G. Aad *et al.*, "Search for contact interactions and large extra dimensions in dilepton events from pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 87, no. 1, pp. 015010-1-015010-25, 2013.
70. ATLAS Collaboration, G. Aad *et al.*, "Search for dark matter candidates and large extra dimensions in events with a photon and missing transverse momentum in pp collision data at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Rev. Lett.*, vol. 110, no. 1, pp. 011802-1-011802-18, 2013.
71. ATLAS Collaboration, G. Aad *et al.*, "Search for direct slepton and gaugino production in final states with two leptons and missing transverse momentum with the ATLAS detector in pp collisions at $\sqrt{s} = 7$ TeV", *Phys. Lett., Sect. B*, vol. 718, no. 3, pp. 879-901, 2013.
72. ATLAS Collaboration, G. Aad *et al.*, "Search for new phenomena in the $WW \rightarrow \ell\nu\ell'\nu'$ final state in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", *Phys. Lett., Sect. B*, vol. 718, no. 3, pp. 860-867, 2013.
73. ATLAS Collaboration, G. Aad *et al.*, "Measurement of jet shapes in top-quark pair events at $\sqrt{s} = 7$ TeV using the ATLAS detector", *The European Physical Journal C*, vol. 73, str. 2676-1-2676-31, 2013.
74. AUGER Collaboration, P. Abreu *et al.*, "Bounds on the density of sources of ultra-high energy cosmic rays from the Pierre Auger Observatory", *Journal of cosmology and astroparticle physics*, vol. 2013, no. 5, 18 pp., may 2013.
75. AUGER Collaboration, P. Abreu *et al.*, "Constraints on the origin of cosmic rays above 10^{18} eV from large-scale anisotropy searches in data of the Pierre Auger Observatory", *The Astrophysical Journal Letters*, vol. 762, no. 1, pp. L13-1-L13-8, 2013.
76. AUGER Collaboration, P. Abreu *et al.*, "Identifying clouds over the Pierre Auger Observatory using infrared satellite data", *Astropart. Phys.*, vol. 50/52, pp. 92-101, 2013.
77. AUGER Collaboration, P. Abreu *et al.*, "Interpretation of the depths of maximum of extensive air showers measured by the Pierre Auger Observatory", *Journal of cosmology and astroparticle physics*, vol. 2013, no. 2, art. no. 26, 19 pp., feb. 2013.
78. AUGER Collaboration, P. Abreu *et al.*, "Techniques for measuring aerosol attenuation using the Central Laser Facility at the Pierre Auger Observatory", *Journal of instrumentation*, vol. 8, no. 4, pp. P04009-1-P04009-27, 2013.
79. B. Arvidsson, Vladimir Cindro, B. T. Huffman, C. Issever, P. K. Teng, A. R. Weidberg, J. A. Sam Wilson, "A study of the effect of radiation on the mechanical strength of optical fibres", *Journal of instrumentation*, vol. 8, no. 5, pp. P05011-1-P05011-18, 2013.
80. AUGER Collaboration, C. Berat *et al.*, "Radio detection of extensive air showers at the Pierre Auger Observatory", In: Proceedings of the 12th Pisa Meeting on Advanced Detectors, La Biodola, Isola d'Elba, Italy, May 20-26, 2012, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 718, pp. 471-474, 2013.
81. Belle Collaboration, V. Bhardwaj *et al.*, "Evidence of a new narrow resonance decaying to $\chi_{c1}\gamma$ in $B \rightarrow \chi_{c1}\gamma K$ ", *Phys. Rev. Lett.*, vol. 111, no. 3, pp. 032001-1-032001-7, 2013.
82. Belle Collaboration, K. Chilikin *et al.*, "Experimental constraints on the spin and parity of the $Z(4430)^{++}$ ", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 88, no. 7, pp. 074026-1-074026-12, 2013.
83. Belle Collaboration, R. Chistov *et al.*, "First observation of Cabibbo-suppressed $\Xi_c^0 \rightarrow \Xi^- K^+$ decays", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 88, no. 7, pp. 071103-1-071103-7, 2013.
84. Belle Collaboration, J. Dalseno *et al.*, "Measurement of the CP violation parameters in $B^0 \rightarrow \pi^+\pi^-$ Decays", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 88, no. 9, pp. 092003-1-092003-11, 2013.
85. Belle Collaboration, Y. -T. Duh *et al.*, "Measurements of branching fractions and direct CP asymmetries for $B \rightarrow K\pi$, $B \rightarrow \pi\pi$ and $B \rightarrow KK$ decays", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 87, no. 3, pp. 031103-1-031103-8, 2013.
86. Belle Collaboration, S. Esen *et al.*, "Precise measurement of the branching fractions for $B_s^0 \rightarrow D_s^{*+} D_s^{*-}$ and first measurement of the $D_s^{*+} D_s^{*-}$ polarization using e^+e^- collisions", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 87, 3, pp. 031101-1-031101-6, 2013.
87. Belle Collaboration, V. Gaur *et al.*, "Evidence for the decay $B^0 \rightarrow K^+ K^- \pi^0$ ", *Phys. Rev., D Part. Fields Gravit. Cosmol.*, vol. 87, no. 9, pp. 091101-1-091101-7, 2013.
88. AUGER Collaboration, Javier G. Gonzalez *et al.*, "Search for ultra-high energy neutrinos with the Pierre Auger Observatory", In: The future of high-energy neutrino astronomy, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 725, pp. 80-84, 2013.
89. Belle Collaboration, K. Hara *et al.*, "Evidence for $B^- \rightarrow \tau^- \bar{\nu}_\tau$ with a hadronic tagging method using the full data sample of Belle", *Phys. Rev. Lett.*, vol. 110, no. 13, pp. 131801-1-131801-6, 2013.
90. AUGER Collaboration, John L. Kelley *et al.*, "Data acquisition, triggering, and filtering at the Auger Engineering Radio Array", In: The future of high-energy neutrino astronomy, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 725, pp. 133-136, 2013.
91. Borut Paul Kerševan, E. Richter-Waß, "The Monte Carlo event generator AcerMC versions 2.0 to 3.8 with interfaces to PYTHIA 6.4, HERWIG 6.5 and ARIADNE 4.1", *Comput. Phys. Commun.*, vol. 184, iss. 3, pp. 919-985, 2013.
92. Belle Collaboration, B. H. Kim *et al.*, "Search for an H -dibaryon with mass near $2m_\Lambda$ in $Y(1S)$ and $Y(2S)$ decays", *Phys. Rev. Lett.*, vol. 110, no. 22, pp. 222002-1-222002-6, 2013.
93. AUGER Collaboration, Matthias Kleifges *et al.*, "Measurement of cosmic ray air showers using MHz radio-detection techniques at the Pierre Auger Observatory", In: Proceedings of the 12th Pisa Meeting on Advanced Detectors, La Biodola, Isola d'Elba, Italy, May 20-26, 2012, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 718, pp. 499-501, 2013.
94. Belle Collaboration, B. R. Ko *et al.*, "Search for CP violation in the decay $D^+ \rightarrow K_S^0 K^+$ ", *J. high energy phys.*, vol. 2013, no. 2, pp. 098-1-098-15, 2013.

95. Samo Korpar, Rok Dolenc, Peter Križan, Rok Pestotnik, Aleš Stanovnik, "Study of a Cherenkov TOF-PET module", In: Proceedings of the 13th Vienna Conference on Instrumentation, VCI2013, 11-15 February 2013, Vienna, Austria, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 732, pp. 595-598, 2013.
96. Gregor Kramberger, Vladimir Cindro, Igor Mandić, Marko Mikuž, Marko Zavrtnik, "Charge collection studies on custom silicon detectors irradiated up to 1.6×10^{17} n_{eq}/cm²", *Journal of instrumentation*, vol. 8, str. P08004-1-P08004-13, 2013.
97. Peter Križan, "Overview of particle identification techniques", In: TRDs for the Third Millennium: proceedings of the 4th Workshop on Advanced Transition Radiation Detectors for Accelerators and Space Application, September 14-16, 2011, Bari, Italy, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 706, pp. 48-54, 2013.
98. Belle Collaboration, P. Krokovny *et al.*, "First observation of the $Z_b^0(10610)$ in a Dalitz analysis of $Y(10860) \rightarrow Y(nS)\pi^0\pi^0$ ", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 88, no. 5, pp. 052016-1-052016-11, 2013.
99. AUGER Collaboration, Daniel Kruppke-Hansen *et al.*, "Extending the Pierre Auger Observatory to explore the ankle of the cosmic ray spectrum", In: The origins of cosmic rays: resolving Hess's century-old puzzle, 38th COSPAR Scientific Assembly, Bremen, 2010, *Adv. Space Res.*, vol. 51, no. 2, pp. 286-289, 2013.
100. Belle Collaboration, M. Leitgab *et al.*, "Precision measurement of charged pion and kaon multiplicities in e^+e^- annihilation at $\sqrt{s} = 10.52$ GeV", *Phys. rev. Lett.*, vol. 111, no. 6, pp. 062002-1-062002-7, 2013.
101. Belle Collaboration, Z. Q. Liu *et al.*, "Study of $e^+e^- \rightarrow \pi^+\pi^-J/\psi$ and observation of a charged charmonium-like state at Belle", *Phys. rev. Lett.*, vol. 110, no. 25, pp. 252002-1-252002-7, 2013.
102. Belle Collaboration, D. Liventsev *et al.*, "Search for heavy neutrinos at Belle", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 87, no. 7, pp. 071102-1-071102-7, 2013.
103. Belle Collaboration, O. Lutz *et al.*, "Search for $B \rightarrow h^{(*)}v\bar{u}$ with the full Belle Y(4S) data sample", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 87, no. 11, pp. 111103-1-111103-7, 2013.
104. Igor Mandić, "Silicon sensors for HL-LH C tracking detectors", In: Proceedings of the 13th Vienna Conference on Instrumentation, VCI2013, 11-15 February 2013, Vienna, Austria, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 732, pp. 126-129, 2013.
105. Igor Mandić, Vladimir Cindro, Andrej Gorišek, Gregor Kramberger, Marko Mikuž, Marko Milovanović, Marko Zavrtnik, "TCT measurements of irradiated strip detectors with a focused laser beam", *Journal of instrumentation*, vol. 8, pp. P04016-1-P04016-14, 2013.
106. Nejc Mekiš, Dejan Žontar, Damijan Škrk, "The effect of breast shielding during lumbar spine radiography", *Radiol. oncol. (Ljublj.)*, vol. 47, no. 1, pp. 26-31, II, mar. 2013.
107. Belle Collaboration, M. Miyazaki *et al.*, "Search for lepton-flavor and lepton-number-violating $\tau \rightarrow \ell h h'$ decay modes", *Phys. Lett., Sect. B*, vol. 719, no. 4/5, pp. 346-353, 2013.
108. Belle Collaboration, M. Nayak *et al.*, "Evidence for the suppressed decay $B^- \rightarrow DK^-, D \rightarrow K^+\pi^-\pi^0$ ", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 88, no. 9, pp. 091104-1-091104-7, 2013.
109. Belle Collaboration, C. Oswald *et al.*, "Measurement of the inclusive semileptonic branching fraction measurement of the inclusive semileptonic branching fraction $B(B_s^0 \rightarrow X^-\ell^+\nu_\ell)$ at Belle", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 87, no. 7, pp. 072008-1-072008-10, 2013.
110. Rok Pestotnik *et al.* (23 authors), "Aerogel RICH for forward PID at Belle II", In: Proceedings of the 13th Vienna Conference on Instrumentation, VCI2013, 11-15 February 2013, Vienna, Austria, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 732, pp. 371-374, 2013.
111. Belle Collaboration, M. Prim *et al.*, "Angular analysis of $B^0 \rightarrow \phi K^+$ decays and search for CP violation at Belle", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 88, no. 7, pp. 072004-1-072004-15, 2013.
112. Belle Collaboration, S. Sandilya *et al.*, "Search for bottomonium states in exclusive radiative $Y(2S)$ decays", *Phys. rev. Lett.*, vol. 111, no. 11, pp. 112001-1-112001-6, 2013.
113. Belle Collaboration, C. P. Shen *et al.*, "Measurement of exclusive (1S) and (2S) decays into vector-pseudoscalar final states", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 88, no. 1, pp. 011102-1-011102-8, 2013.
114. Belle Collaboration, C. P. Shen *et al.*, "Study of exclusive $B \rightarrow X_u \ell \nu$ decays and extraction of $|V_{ub}|$ using full reconstruction tagging at the Belle experiment", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 88, no. 3, pp. 032005-1-032005-25, 2013.
115. Belle Collaboration, C. P. Shen *et al.*, "Measurement of $e^+e^- \rightarrow \omega\pi^0, K^*(892)\bar{K}$ and $K_2^*(1430)\bar{K}$ at \sqrt{s} near 10.6 GeV", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 88, no. 5, pp. 052019-1-052019-9, 2013.
116. Belle Collaboration, E. Solovieva *et al.*, "Evidence for $B_s^0 \rightarrow \Lambda_c^+ \bar{\Lambda} \pi^-$ ", *Phys. Lett., Sect. B*, vol. 726, no. 1/3, pp. 206-210, 2013.
117. Graeme Douglas Stewart, Richard Bates, Celeste Fleta Corral, Gregor Kramberger, Manuel Lozano Fantoba, Marko Milovanović, Giulio Pellegrini, "Analysis of edge and surface TCTs for irradiated 3D silicon strip detectors", *Journal of instrumentation*, vol. 8, issue 3, pp. P03002-1-P03002-24, 2013.
118. Andrej Studen *et al.* (16 authors), "Silicon detectors for combined MRPET and MRSPECT imaging", In: Proceedings of the PET/MR and SPECT/MR: New Paradigms for Combined Modalities in Molecular Imaging Conference, 26-30 May 2012, La Biodola, Isola d'Elba, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 702, pp. 88-90, 2013.
119. Damijan Škrk, Dejan Žontar, "Estimated collective effective dose to the population from nuclear medicine examinations in Slovenia", *Radiol. oncol. (Ljublj.)*, vol. 47, no. 3, pp. 304-310, VII, sep. 2013.
120. Belle Collaboration, U. Tamponi *et al.*, "Study of the hadronic transitions $Y(2S) \rightarrow (\eta, \pi^0)Y(1S)$ at Belle", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 87, no. 1, pp. 011104-1-011104-6, 2013.
121. Belle Collaboration, F. Thorne *et al.*, "Measurement of the Decays $B_s^0 \rightarrow J/\psi\phi(1020), B_s^0 \rightarrow J/\psi f_2(1525)$ and $B_s^0 \rightarrow J/\psi K^+K^-$ ", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 88, no. 11, pp. 114006-1-114006-8, 2013.
122. Gianluca Traversi *et al.* (13 authors), "Review of radiation damage studies on DNW CMOS MAPS", In: Proceedings of the 9th International Conference on Radiation Effects on Semiconductor Materials Detectors and Devices, 9-12 October 2012, Florence, Italy, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 730, pp. 155-158, 2013.
123. Belle Collaboration, S. Uehara *et al.*, "High-statistics study of K_S^0 pair production in two-photon collisions", *Progress of theoretical and experimental physics*, vol. 2013, no. 12, pp. 123C01-1-123C01-45, 2013.
124. Jenia Vassileva *et al.* (43 authors), "IAEA survey of paediatric computed tomography practice in 40 countries in Asia, Europe, Latin America and Africa: procedures and protocols", *Eur. radiol.*, vol. 23, issue 3, pp. 623-631, 2013.
125. Belle Collaboration, X. L. Wang *et al.*, "Observation of $\psi(4040)$ and $\psi(4160)$ decay into J/ψ ", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 87, no. 5, pp. 051101-1-051101-7, 2013.
126. Belle Collaboration, E. White *et al.*, "Measurement of the wrong-sign decay $D^0 \rightarrow K^+\pi^-\pi^+\pi^-$ ", *Phys. rev., D Part. fields gravit. cosmol.*, vol. 88, no. 5, pp. 051101-1-051101-6, 2013.
127. AUGER Collaboration, Bruno Zamorano *et al.*, "Up-to-date results from the Pierre Auger Observatory", In: Matter to the deepest, XXXVII International Conference of Theoretical Physics, Ustroń, Poland, September 1-6, 2013, *Acta Phys. Pol., B*, vol. 44, no. 11, pp. 2317-2322, 2013.
128. Belle Collaboration, Anže Zupanc *et al.*, "Measurements of branching fractions of leptonic and hadronic D_s^+ meson decays and extraction of the D_s^+ meson decay constant", *J. high energy phys.*, vol. 2013, no. 9, pp. 139-1-139-35, 2013.

REVIEW ARTICLE

1. AUGER Collaboration, P. Abreu *et al.*, "Ultra-high energy neutrinos at the Pierre Auger Observatory", *Adv. High Energy Phys.*, vol. 2013, pp. 1-18, 2013.
2. Peter Križan, Samo Korpar, "Photodetectors in particle physics experiments", *Annu. rev. nucl. part. sci.*, vol. 63, pp. 329-349, 2013.
3. The ALEPH Collaboration, The DELPHI Collaboration, The L3 Collaboration, The OPAL Collaboration, The LEP Electroweak Working Group, S. Schael *et al.*, "Electroweak measurements in electron-positron collisions at W-boson-pair energies at LEP", *Phys. rep.*, vol. 532, no. 4, pp. 119-244, 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

1. Marko Mikuž, "The Higgs hunt with ATLAS at LHC", In: *Proceedings of the 4th International Conference on Time and Matter, 4-8 March 2013, Venice, Italy*, Martin O'Loughlin, ed., Samo Stanič, ed., Darko Veberič, ed., Nova Gorica, University, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. AUGER Collaboration, Eun-Joo Ahn *et al.*, "Inferences about the mass composition of cosmic rays from data on the depth of maximum at the Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013*, pp. [1-2].

2. AUGER Collaboration, Telescope Array Collaboration and Yakutsk Collaboration, Jeff Allen *et al.*, "Air shower simulation and hadronic interactions", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 01007-1-01007-15, 2013.
3. AUGER Collaboration, Rogerio M. De Almeida *et al.*, "Constraints on the origin of cosmic rays from large scale anisotropy searches in data of the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
4. AUGER Collaboration, Telescope Array Collaboration and Yakutsk Collaboration, Jaime Alvarez-Muñiz *et al.*, "Review of the Multimessenger Working Group at UHECR-2012", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 01009-1-01009-14, 2013.
5. AUGER Collaboration, Telescope Array Collaboration and Yakutsk Collaboration, E. Barcikowski *et al.*, "Mass composition working group report", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 01006-1-01006-14, 2013.
6. AUGER Collaboration, Julia Bäuml *et al.*, "Measurement of the optical properties of the Auger fluorescence telescopes", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
7. AUGER Collaboration, A. M. van den Berg *et al.*, "Results from and prospects for the Auger Engineering Radio Array", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 08006-1-08006-7, 2013.
8. AUGER Collaboration, Carla Bonifazi *et al.*, "The monitoring system of the Pierre Auger Observatory: on-line and long-term data quality controls", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
9. AUGER Collaboration, Johana Chirinos *et al.*, "Cloud monitoring at the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
10. AUGER Collaboration, Telescope Array Collaboration and Yakutsk Collaboration, Bruce Dawson *et al.*, "The energy spectrum of cosmic rays at the highest energies", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 01005-1-01005-15, 2013.
11. AUGER Collaboration, J. R. T. De Mello Neto *et al.*, "Anisotropy studies with the Pierre Auger Observatory", In: *23rd European Cosmic Ray Symposium (and 32nd Russian Cosmic Ray Conference), 3-7 July 2012, Moscow, Russia*, (Journal of physics. Conference series, vol. 409), Bristol, Institute of Physics, 2013, vol. 409, pp. 1-4, 2013.
12. AUGER Collaboration, O. Deligny *et al.*, "Measuring large-scale anisotropy in the arrival directions of cosmic rays detected at the telescope array and the Pierre Auger Observatory above 10^{19} eV", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
13. AUGER Collaboration, Telescope Array Collaboration and Yakutsk Collaboration, O. Deligny *et al.*, "Review of the anisotropy working group at UHECR-2012", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 01008-1-01008-13, 2013.
14. AUGER Collaboration, Pedro Facal San Luis *et al.*, "Detection of cosmic rays using microwave radiation at the Pierre Auger Observatory", In: *5th International Workshop on Acoustic and Radio EeV Neutrino Detection Activities, Arena 2012, Erlangen, Germany, 19-22 June 2012*, (AIP conference proceedings, vol. 1535), Robert Lahmann, ed., Melville, New York, American Institute of Physics, 2013, pp. 224-228.
15. AUGER Collaboration, Pedro Facal San Luis *et al.*, "Status of the program for microwave detection of cosmic rays at the Pierre Auger observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 08009-1-08009-7, 2013.
16. AUGER Collaboration, Glennys Farrar *et al.*, "The muon content of hybrid events recorded at the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
17. AUGER Collaboration, Romain Gafor *et al.*, "Detection of cosmic rays using microwave radiation at the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
18. AUGER Collaboration, D. García-Gómez *et al.*, "Measurement of atmospheric production depths of muons with the Pierre Auger Observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 04008-1-04008-7, 2013.
19. AUGER Collaboration, Diego García-Gómez *et al.*, "Observations of the longitudinal development of extensive air showers with the surface detectors of the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
20. AUGER Collaboration, Christian Glaser *et al.*, "Energy estimation for cosmic rays measured with the Auger Engineering Radio Array", In: *5th International Workshop on Acoustic and Radio EeV Neutrino Detection Activities, Arena 2012, Erlangen, Germany, 19-22 June 2012*, (AIP conference proceedings, vol. 1535), Robert Lahmann, ed., Melville, New York, American Institute of Physics, 2013, pp. 68-72.
21. AUGER Collaboration, S. Grebe *et al.*, "Spectral index analysis of the data from the Auger Engineering Radio Array", In: *5th International Workshop on Acoustic and Radio EeV Neutrino Detection Activities, Arena 2012, Erlangen, Germany, 19-22 June 2012*, (AIP conference proceedings, vol. 1535), Robert Lahmann, ed., Melville, New York, American Institute of Physics, 2013, pp. 73-77.
22. AUGER Collaboration, Telescope Array Collaboration, William F. Hanlon *et al.*, "Progress towards understanding the analyses of mass composition made by the Auger and Telescope Array Collaborations", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
23. AUGER Collaboration, Andreas Haungs *et al.*, "AugerNext: innovative research studies for the next generation ground-based ultra-high energy cosmic ray experiment", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 08019-1-08019-7, 2013.
24. AUGER Collaboration, Tim Huege *et al.*, "Probing the radio emission from cosmic-ray-induced air showers by polarization measurements", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
25. AUGER Collaboration, Balázs Kégl *et al.*, "Measurement of the muon signal using the temporal and spectral structure of the signals in surface detectors of the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
26. Gregor Kramberger, Vladimir Cindro, Andrej Gorišek, Igor Mandić, Marko Mikuž, Marko Zavrtanik, "Effects of bias voltage during priming on operation of diamond detectors", V: *Vertex 2012: 21st International Workshop on Vertex Detectors, 16-21 September 2012, Jeju Islands, Republic of Korea*, (Proceedings of science, Vertex 2012), Trieste, Sissa, 2013, pp. 013-1-013-10.
27. Gregor Kramberger, Vladimir Cindro, Igor Mandić, Marko Mikuž, Marko Milovanović, Marko Zavrtanik, "Electric field modeling in heavily irradiated silicon detectors based on Edge-TCT measurements", V: *Vertex 2012: 21st International Workshop on Vertex Detectors, 16-21 September 2012, Jeju Islands, Republic of Korea*, (Proceedings of science, Vertex 2012), Trieste, Sissa, 2013, str. 022-1-022-10.
28. Peter Križan, "Flavour physics at B factories", In: *Proceedings of Nobel Symposium 154 "The Higgs Boson Discovery and Other Recent LHC Results", May 13-17, 2013, Krusenberg, Sweden*, (Physica scripta, Vol.

- T158, 2013), Stockholm, Royal Swedish Academy of Sciences, 2013, vol. T158, pp. 014024-1- 014024-8, 2013.
29. Peter Križan, "SuperKEKB and SuperB: flavor physics", In: *Proceedings of the HCP 2012 Hadron Collider Physics Symposium, November 12-16, 2012, Kyoto, Japan*, (EPJ, Applied physics, Vol. 49, 2013), fra, EDP Sciences, 2013, vol. 49, pp. 11002-1-11002-5, 2013.
 30. AUGER Collaboration, Daniel Kuempel *et al.*, "Directional search for ultra-high energy photons with the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
 31. AUGER Collaboration, Karim Louedec *et al.*, "Origin of atmospheric aerosols at the Pierre Auger Observatory using backward trajectory of air masses", In: *23rd European Cosmic Ray Symposium (and 32nd Russian Cosmic Ray Conference), 3-7 July 2012, Moscow, Russia*, (Journal of physics. Conference series, vol. 409), Bristol, Institute of Physics, 2013, vol. 409, pp. 1-4, 2013.
 32. AUGER Collaboration, Simone Maldera *et al.*, "Limit on UHE neutrino fluxes from the Pierre Auger Observatory", *Acta polytech.*, vol. 53, no. supp., pp. 755-758, 2013.
 33. AUGER Collaboration, Simone Maldera *et al.*, "Measuring the accuracy of the AMIGA muon counters at the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
 34. AUGER Collaboration, Jennifer Maller *et al.*, "Study of ultra-high energy cosmic rays from the radio signal at the Pierre Auger Observatory", In: *Proceedings of the Annual Meeting of the French Society of Astronomy & Astrophysics, Montpellier, June 4-7, 2013 [also] SF2A 2013*, L. Cambrésy, ed., [S. I.], Société Française d'Astronomie et d'Astrophysique, 2013, pp. 465-469.
 35. Erik Margan, Rebeka Strgar, Igor Frangež, "Svetlobna terapija: biološke in fizikalne osnove", In: *Konzervativno in kirurško zdravljenje okuženih mehkih tkiv in kosti: [zbornik predavanj]*, 8. simpozij o ranah, Portorož, 25. do 26. april 2013, Dragica Smrke, ed., Janja Nikolič, ed., Ljubljana, Klinični oddelek za kirurške okužbe, Kirurška klinika, Univerzitetni klinični center, 2013, pp. 135-150.
 36. AUGER Collaboration, Ioana C. Maris *et al.*, "Measurement of the energy spectrum of cosmic rays at the highest energies using data from Pierre Auger Observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 04002-1-04002-7, 2013.
 37. AUGER Collaboration, Telescope Array Collaboration, J. N. Matthews *et al.*, "Progress towards a cross-calibration of the Auger and Telescope Array fluorescence telescopes via an air-borne light source", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
 38. AUGER Collaboration, Maximilien Melissas *et al.*, "Recent developments at the Auger Engineering Radio Array", In: *5th International Workshop on Acoustic and Radio EeV Neutrino Detection Activities, Arena 2012, Erlangen, Germany, 19-22 June 2012*, (AIP conference proceedings, vol. 1535), Robert Lahmann, ed., Melville, New York, American Institute of Physics, 2013, pp. 63-67.
 39. AUGER Collaboration, M. I. Micheletti *et al.*, "Aerosol characterization at the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
 40. AUGER Collaboration, Moritz Münchmeyer *et al.*, "Anisotropy studies with the Pierre Auger Observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 04011-1-04011-6, 2013.
 41. AUGER Collaboration, J. L. Navarro *et al.*, "Astronomy of ultra-high energy neutral particles with the Pierre Auger Observatory", In: *23rd European Cosmic Ray Symposium (and 32nd Russian Cosmic Ray Conference), 3-7 July 2012, Moscow, Russia*, (Journal of physics. Conference series, vol. 409), Bristol, Institute of Physics, 2013, vol. 409, pp. 1-6, 2013.
 42. AUGER Collaboration, S. Navas *et al.*, "The search for ultra-high energy neutrinos at the Pierre Auger Observatory", In: *Proceedings of the Neutrino Oscillation Workshop, Conca Specchiulla, Otranto, Italy, 9-15 September 2012*, (Nuclear physics B, Proceedings supplement, Vol. 237/238), Paolo Bernardini, ed., Gianluigi Fogli, ed., Eligio Lisi, ed., Amsterdam, Elsevier, 2013, vol. 237/238, pp. 236-238, 2013.
 43. AUGER Collaboration, S. Navas *et al.*, "Search for ultra-high energy neutrinos at the Pierre Auger Observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 05003-1-05003-7, 2013.
 44. AUGER Collaboration, Lukas Nellen *et al.*, "The observation of a muon deficit in simulations from data of the Pierre Auger Observatory", In: *23rd European Cosmic Ray Symposium (and 32nd Russian Cosmic Ray Conference), 3-7 July 2012, Moscow, Russia*, (Journal of physics. Conference series, vol. 409), Bristol, Institute of Physics, 2013, vol. 409, pp. 1-4, 2013.
 45. AUGER Collaboration, S. Pastor *et al.*, "Neutrino searches at the Pierre Auger Observatory", In: *The XXV International Conference on Neutrino Physics and Astrophysics Kyoto, Japan, 3-9 June 2012*, (Nuclear physics. B, Proceedings supplement, vol. 235/236), Takashi Kobayashi, ed., Amsterdam, North-Holland, 2013, vol. 235/236, pp. 358-363, 2013.
 46. AUGER Collaboration, Lorenzo Perrone *et al.*, "Results from the Pierre Auger Observatory", In: *ISVHECRI 2012 [also] XVII International Symposium on Very High Energy Cosmic Ray Interactions, Berlin, Germany, August 10-15, 2012*, (EPJ web of conferences, vol. 52), U. Gensh, ed., Les Ulis, EDP Sciences, 2013, vol. 52, pp. 06001-1-06001-7, 2013.
 47. Marko Petrič, "New results on quarkonium spectroscopy and exotic quarkonium-like resonances at B-factors", In: *Proceedings to the Mini-Workshop Looking into Hadrons, Bled, Slovenia, July 7-14, 2013*, (Blejske delavnice iz fizike, vol. 14, no. 1), Bojan Golli, ed., Mitja Rosina, ed., Simon Sirca, ed., Ljubljana, DMFA - založništvo, 2012, vol. 14, no. 1, pp. 45-49, 2013.
 48. AUGER Collaboration, Pablo Pieroni *et al.*, "Ultra-high energy neutrinos at the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
 49. AUGER Collaboration, Diego Ravignani *et al.*, "Measurement of the energy spectrum of cosmic rays above 3×10^{17} eV using the AMIGA 750 m surface detector array of the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
 50. AUGER Collaboration, Benot Revenu *et al.*, "Blind searches for localized cosmic ray excesses in the field of view of the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
 51. AUGER Collaboration, G. Rodriguez *et al.*, "A measurement of the muon number in showers using inclined events detected at the Pierre Auger Observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 07003-1-07003-6, 2013.
 52. AUGER Collaboration, I. Humberto Salazar *et al.*, "Observing ultra high energy cosmic rays with the Pierre Auger Observatory", In: *II Cinvestav-UNAM Symposium on High Energy Physics, Particles & Neutrinos in an Astrophysical Context, México City, México, 8-9 October 2012: in honor of Juan Carlos D'Olivo*, (AIP conference proceedings, vol. 1540), Gerardo Herrera, ed., Melville, New York, American Institute of Physics, 2013, pp. 42-54.
 53. AUGER Collaboration, Francisco Salesa Greus *et al.*, "Searches for Galactic neutron sources with the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro*, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].
 54. AUGER Collaboration, Fred Sarazin *et al.*, "The Pierre Auger Research and Development Array (RDA) in southeastern Colorado: R&D for a giant ground array", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 08017-1-08017-7, 2013.
 55. AUGER Collaboration, V. Scherini *et al.*, "Search for ultra-high energy photons at the Pierre Auger Observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012*, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 05002-1-05002-7, 2013.
 56. AUGER Collaboration, Frank G. Schröder *et al.*, "Radio detection of air showers with the Auger Engineering Radio Array", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de*

- Convenções Sulamérica, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].*
57. AUGER Collaboration, Alexander Schulz *et al.*, "The measurement of the energy spectrum of cosmic rays above 3×10^{17} eV with the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].*
 58. AUGER Collaboration, Mariangela Settimo *et al.*, "Latest results of the Pierre Auger Observatory", In: *From high energy gamma sources to cosmic rays, one century after their discovery: proceedings of the 9th Workshop on Science with the New Generation of High Energy Gamma-ray Experiments, Lecce, Italy, 20-22 June 2012, (Nuclear Physics, B, Proceedings supplements, vol. 239-240), Ivan De Mitri, ed., Amsterdam, Elsevier, 2013, vol. 239/240, pp. 163-168, 2013.*
 59. AUGER Collaboration, Iván Sidelnik *et al.*, "Measurement of the first harmonic modulation in the right ascension distribution of cosmic rays detected at the Pierre Auger Observatory: towards the detection of dipolar anisotropies over a wide energy range", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].*
 60. AUGER Collaboration, Gregory R. Snow *et al.*, "Education and outreach activities of the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].*
 61. AUGER Collaboration, Vitor de Souza *et al.*, "Measurements of the longitudinal shower development with the Pierre Auger Observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 04007-1-04007-7, 2013.*
 62. AUGER Collaboration, Vitor de Souza *et al.*, "An update on the measurements of the depth of shower maximum made at the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-3].*
 63. AUGER Collaboration, Federico Suarez *et al.*, "The AMIGA muon detectors of the Pierre Auger Observatory: overview and status", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].*
 64. AUGER Collaboration, Aurelio S. Tonachini *et al.*, "Observation of elves at the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].*
 65. AUGER Collaboration, Matias J. Tueros *et al.*, "Estimate of the non-calorimetric energy of showers observed with the fluorescence and surface detectors of the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].*
 66. AUGER Collaboration, Ralf Ulrich *et al.*, "Measurement of the proton-air cross-section with the Pierre Auger Observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 07005-1-07005-7, 2013.*
 67. AUGER Collaboration, Michael Unger *et al.*, "Mass sensitive observables of the Pierre Auger Observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 04009-1-04009-6, 2013.*
 68. AUGER Collaboration, Inés Valiño *et al.*, "A measurement of the muon number in showers using inclined events recorded at the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].*
 69. AUGER Collaboration, Laura Valore *et al.*, "Measuring atmospheric aerosol attenuation at the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].*
 70. AUGER Collaboration, E. Varela *et al.*, "The low-energy extensions of the Pierre Auger Observatory", In: *XV Mexican School of Particles and Fields 6-15 September 2012, Puebla, Mexico, (Journal of physics. Conference series, vol. 468), I. Humberto Salazar, ed., Bristol, Institute of Physics, 2013, vol. 468, pp. 1-11, 2013.*
 71. AUGER Collaboration, Valerio Verzi *et al.*, "The energy scale of the Pierre Auger Observatory", In: *33rd International Cosmic Ray Conference, 2-9 July 2013, Centro de Convenções Sulamérica, Rio de Janeiro, Rio de Janeiro, Centro Brasileiro de Pesquisas Físicas, 2013, pp. [1-4].*
 72. AUGER Collaboration, Klaus Weidenhaupt *et al.*, "The Auger engineering radio array", *Acta polytech.*, vol. 53, no. supp., pp. 824-827, 2013.
 73. AUGER Collaboration, Lawrence Wiencke *et al.*, "Interdisciplinary science with large aperture detectors", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 11001-1-11001-7, 2013.*
 74. AUGER Collaboration, A. Yushkov *et al.*, "Measurements of the muon shower content at the Pierre Auger Observatory", In: *UHECR 2012 [also] International Symposium on Future Directions in UHECR Physics, CERN, Geneva, February 13-16, 2012, (EPJ web of conferences, vol. 53), Karl-Heinz Kampert, ed., Les Ulis, EDP Sciences, 2013, vol. 53, pp. 07002-1-07002-7, 2013.*

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Andrej Studen, "Image magnification with PET insert probe", In: *Imaging in nuclear medicine*, Augusto Giussani, ed., Christoph Hoeschen, ed., Berlin, New York, Springer, cop. 2013, pp. 203-222.
2. Andrej Studen, "Physics of imaging in nuclear medicine", In: *Imaging in nuclear medicine*, Augusto Giussani, ed., Christoph Hoeschen, ed., Berlin, New York, Springer, cop. 2013, pp. 19-41.

MENTORING

1. Milan Grkovski, *Development of a high resolution PET probe*: doctoral dissertation, Ljubljana, 2013 (mentor Dejan Žontar).
2. Andrej Seljak, *Proximity focusing RICH with aerogel as radiator*: doctoral dissertation, Ljubljana, 2013 (mentor Samo Korpar).
3. Peter Smerkol, *Measurement of CP violation parameter A_{CP} in weak decays of charmed baryons Λ_c with the Belle detector*: doctoral dissertation, Ljubljana, 2013 (mentor Boštjan Golob).
4. Luka Šantelj, *Measurement of time-dependent CP violation in $B \rightarrow \eta' K_S^0$ decays*: doctoral dissertation, Ljubljana, 2013 (mentor Boštjan Golob).
5. Andrii Tykhonov, *Searches for dark matter and lepton-jets with the ATLAS detector*: doctoral dissertation, Ljubljana, 2013 (mentor Borut Paul Kerševan).
6. Tara Nanut, *Študij vpliva ozadja na meritev razpadov $D^+ \rightarrow \pi^+ l^+ l^- z$ detektorjem Belle*: master's thesis, Ljubljana, 2013 (mentor Boštjan Golob).

DEPARTMENT OF INORGANIC CHEMISTRY AND TECHNOLOGY K-1

The Department of Inorganic Chemistry and Technology is one of the leading groups in the world for the synthesis of new inorganic compounds containing fluorine. The main research fields are: the synthesis of new coordination compounds with different ligands, the chemistry of noble gases, the chemistry of elements of the main groups and the synthesis of new inorganic materials with special properties. A great deal of the activity of the group has been devoted to technological, ecological and safety problems in Slovenia. The group has already been cooperating closely with Slovenian industry for more than thirty years. It is also active in the field of education and in the field of the promotion of natural sciences among students at colleges and elementary schools.



Head:

Asst. Prof. Gašper Tavčar

In the research field of new inorganic compounds the study of the VOF_3 reactivity towards different fluoride Lewis bases was continued. The reaction of VOF_3 with SeF_4 yields $\text{SeF}_3[\text{V}_2\text{O}_2\text{F}_7]$. Xenon fluorides reacted with VOF_3 according to their basicity. The Lewis acid-base adduct $\text{XeF}_2\cdot\text{VOF}_3$ was isolated in the XeF_2 system, while the reaction with XeF_6 led to the formation of $\text{XeF}_5[\text{VOF}_4]$ salt. XeF_4 as a weaker base does not form any kind of product with VOF_3 . XeF_2 as a ligand to a metal centre was studied over the past decade and a whole series of compounds was prepared. One of the latest examples is $[\text{Ca}_3(\text{XeF}_2)_7][\text{NbF}_6]_6$, in which there are three different calcium centres with completely different coordination spheres. The numbers of XeF_2 molecules connected to calcium atoms are four, three and even one. Fluorine atoms from NbF_6 units complete the coordination sphere.

During the investigation of reactions between alkaline metal fluorides and titanium tetrafluoride in an anhydrous hydrogen fluoride solvent, single crystals of $\text{K}_4\text{Ti}_8\text{F}_{36}\cdot 8\text{HF}$ and $\text{Rb}_4\text{Ti}_8\text{F}_{36}\cdot 6\text{HF}$ were prepared and their crystal structures determined. Both structures contain previously unknown discrete octameric $[\text{Ti}_8\text{F}_{36}]^{4-}$ anions. Each of them is constructed from eight TiF_6 octahedral units sharing joint vertices and connected in that way into a cube. The herein reported $[\text{Ti}_8\text{F}_{36}]^{4-}$ anion represents the largest known example of discrete oligomeric species found in fluoride compounds with the metal in the oxidation state four.

Anion $[\text{Ti}_8\text{F}_{36}]^{4-}$ represents the largest known example of discrete oligomeric species found in fluoride compounds with a metal in oxidation state four.

The compounds $\text{H}_3\text{O}[\text{Ti}_2\text{F}_9]$, $\text{H}_3\text{O}[\text{SnF}_5]$, $(\text{H}_3\text{O})_2[\text{SnF}_6]$ and $\text{Na}(\text{HF})[\text{Sn}_2\text{F}_9]$ were successfully synthesized and characterized. The structure of $\text{Na}(\text{HF})[\text{Sn}_2\text{F}_9]$ reveals a rare example of HF acting as a ligand towards sodium centres and simultaneously interacting through hydrogen bonding with the double chain of the polymeric anion $([\text{Sn}_2\text{F}_9]^-)_\infty$. Until now, the description of the aforementioned anion was based only on data obtained from spectroscopic measurements.

In cooperation with the University of Warsaw (Poland), IMCN (*Université Catholique de Louvain*) and the University in Ljubljana (FCGE) we have investigated the magnetic and structural properties of potassium trifluoroargentate(II). The results of the magnetic studies show strong super-exchange antiferromagnetic interactions between neighbouring silver(II) ions within the chains. The strength of the interactions is reminiscent of that found in superconductors based on copper(II) oxides.

The syntheses of copper(I) salts p-complexes with functional derivatives of selected organic compounds were performed, and the obtained products were characterized. Crystalline copper(I) π -complexes with fluorine containing anions $[\text{Cu}(\text{L})\text{CF}_3\text{SO}_3]$ and $[\text{Cu}_2(\text{L})_2(\text{H}_2\text{O})_2](\text{SiF}_6)_2\cdot 2.5\text{H}_2\text{O}$ (L - 2-(allyl)-amino-5-methyl-1,3,4-thiadiazole) have been obtained by an electrochemical technique and investigated. The organic molecule L acts as a chelate-bridging tridentate ligand, connected to copper(I) by two N atoms of a thiadiazole ring and a C=C bond from the allyl group resulting in the formation of stable cationic dimers $\{[\text{Cu}(\text{L})]_2\}^{2+}$. The direct synthesis of coordination compounds from a mixture Cu-DMSO- CCl_4 -ligand has been explored. A unique bridging mode of the DMSO molecule in the compound $2\text{CuCN}\cdot\text{DMSO}$ was observed. DMSO is bonded to two Cu^+ centres *via* oxygen and sulphur atoms.

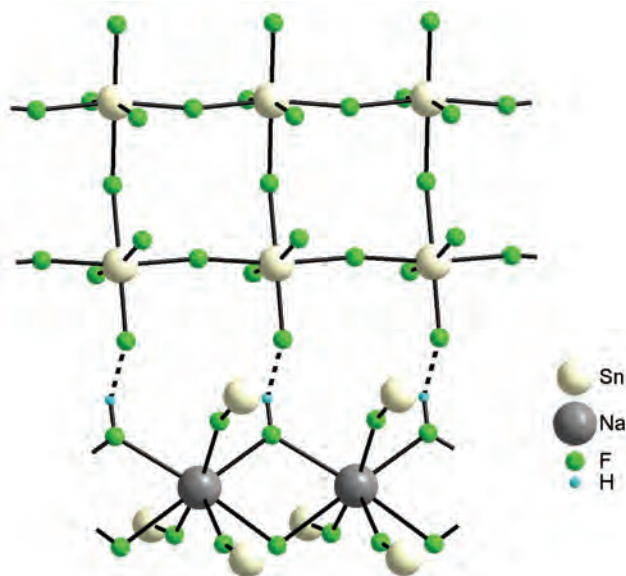


Figure 1: Coordination sphere of sodium atoms and bonding of HF molecules in the structure of $\text{Na}(\text{HF})[\text{Sn}_2\text{F}_9]$

New catalytically active transition-metal sulphides-based nanomaterials are especially effective in the hydrodeoxygenation of liquefied biomass.

tions are based on a smaller set of parameters and enable the calculations of entropies of formation of unknown anions with a precision and accuracy comparable to earlier equations.

Possibilities for the direct preparation of fluoride aerogels were further investigated. Work in this field was focused on the determination of the main solvothermal conditions that lead to the formation of aerogels based on

aluminium(III) fluoride, AlF_3 . It was found that very open and voluminous aerogel structures are obtained only when methanol is one of the applied non-aqueous solvents, and when the drying of the precursor sols or gels is performed at supercritical conditions. Products from such preparations consisted of elongated and partially crystallised fluoride nanoparticles with remarkably uniform shapes and dimensions. The crystal structure perfectly corresponded to $\beta-AlF_3$, although the determined composition, $AlF_{3-x}(OH)_x \cdot yH_2O$ ($0 < x < 0,2$), indicated a partial F⁻ for HO⁻ ion exchange, which can be associated with partial hydrolysis. In systems containing methanol, the formation of thermally and chemically very stable surface methoxide groups was observed. These groups apparently favour the formation of elongated particles and prevent their agglomeration, and, simultaneously, block the surface Lewis acid sites, which is reflected in the strongly reduced catalytic activity. The importance of these investigations is not solely in the addition of a new class of materials to the group of so-called "exotic" aerogels, but also in the established capability of the method for the preparation of fluoride nanoparticles with well-defined sizes and shapes. Fluorides with such characteristics cannot be obtained by conventional synthetic approaches.

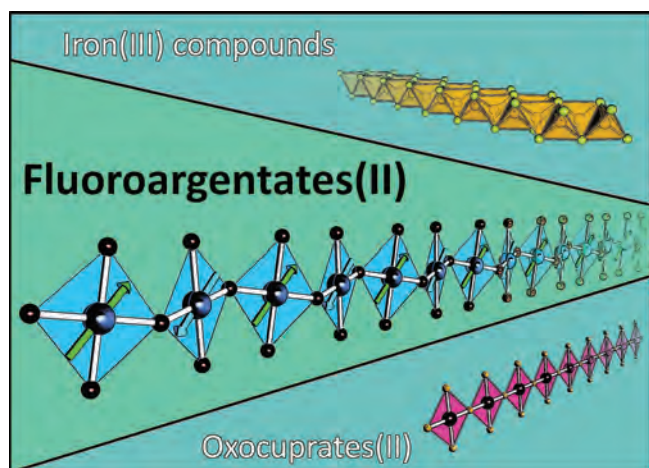


Figure 2: Comparison of the structure of $KAgF_3$ with structures of oxocuprates(II) and iron(III) based superconductors (back cover of the journal *Chem. Comm.* 49 (2013), 6262–6264)

The economic utilization of liquefied wood as a fuel is inhibited by its high oxygen content. However, with the catalytic hydrodeoxygenation (HDO) process the oxygen content in liquefied wood can be lowered to such an extent that processed liquefied wood becomes a competitive fuel. New catalytically active transition-metal sulphides based nanomaterials were prepared and are especially effective in fuel production HDO reactions and represent a

low-cost alternative to noble-metal-based catalysts. The research work was done in cooperation with the National Institute of Chemistry, Slovenia.

In the EU FP7 project Integ-Risk we continued our work on methods and tools for the management of new and emerging risks in industry. In that respect we tested in the industrial zone of Luka Koper (Port of Koper), Slovenia and in the Industrial Zone Pančevo, Serbia, methods for: i.) analysing the risks between the client and contractors, ii.) an approach to the selection of the key performance indicators (applied to the process safety), iii.) an approach to the analysis of energy-supply security, iv.) an approach to the assessment of the health effects due to exposure to hazardous substances, v.) the domino accident potential among two industrial establishments, vi.) a tool for the spatial integration of the risk information (process safety aspect) and vii.) an approach to consider the risk information within the process of land use planning/plan elaboration (at the local community level). In 2013 we mainly reported about the work done on the final project meetings and submitted reports.

We continued work within EU COST action ES 1006 - Evaluation, improvement and guidance for the use of local-scale emergency prediction and response tools for airborne hazards in built environments. Within the action we participate in the assessment of the accuracy of the existing hazardous substances atmospheric dispersion models into the ambient air in a complex/urban environment, as well as in the preparation of the best-practice guideline for the selection, modelling, use and interpretation of the results, including real-time support to the emergency response team managers.

In 2013 we started a new EU 7FP project TOSCA (Total Operations Management for Safety Critical Activities) in which we participate as a partner. The project deals with the integration of the individual management aspects industrial operations as a total safety, quality and productivity management system (at the company level), covering the whole life cycle of the product. In the project we participate during the definition of industrial needs (with a special emphasis on the SME



Figure 3: *Acta Chimica Slovenica*, Issue No. 3, 2013, was dedicated to prof. Boris Žemva on the occasion of his receiving the Zois Award for lifetime achievements in the field of inorganic fluorine chemistry (Design cover: KULT, oblikovalski studio, Simon Kajtna s.p.)

companies), the development and integration of the TOSCA methods and tools, the demonstration and validation of the proposed methods and tools for the industrial partners (also from Slovenia) and during the evaluation, standardization and dissemination of the project results.

In this year we were invited to join the end-user platform of the EU 7FP project EDEN (End User Driven Demo for CBRNe), which started in September 2013. In the project, which deals with the assessment and preparedness for terrorist risks (aspect of security), we participate on the basis of our previous experiences in the assessment of such threats to industrial operations.

The IPA project Adriacold "Diffusion of cooling and refreshing technologies using the solar energy resource in the Adriatic regions", started in October 2012, was continued in 2013 with partners from Italy, Slovenia, Croatia, Bosnia & Herzegovina and Albania. The JSI leads the Work Task "Monitoring and data mining", which comprises the planning and systematic collection of performance data for six pilot and testing cooling plants (in the cities of Dubrovnik and Rijeka (Croatia), Piran (Slovenia), Bazovica, Rimini and Bari (Italy)), and data analysis. Within the Work Task 4 "Installation of pilot and demonstration plants" we developed, along with Slovenian industry, which designs and markets such equipment, basic and minimal requirements for the monitoring equipment, needed for an effective evaluation of the cooling equipment efficiency. These requirements are one of the inputs for the tenders for the installation and operation of sustainable cooling devices. The requirements include sensor quality specifications and requirements for the safe storage and communication of the operational data.

By joining in the EMILIE project (Enhancing Mediterranean Initiatives Leading Innovation and SMEs to building Energy Efficiency Technologies) in 2013, carried out as part of the transnational cooperation program in the Mediterranean region, we became one of the members of the group of six research institutions to test and disseminate knowledge on innovative and competing technologies, products and solutions in the field of energy efficiency in buildings. The purpose of the 30-month project is to provide support to small and medium-sized enterprises in the development, deployment and use of energy efficient technologies, thus contributing to strengthening the competitiveness and innovation of their products and processes. Within the project, the Institute is preparing a larger demonstration pilot facility, with several built-in innovative solar thermal technologies and systems for the use of waste heat. It will serve for the assessment, display and promotion of the concept of a new infrastructural economic model, which would allow greater use of solar energy and cost reduction for end-users in the tertiary sector.

The work within the project "Methodology of fixation of CO₂ on fly ash" was continued along with the partners from the Razvojni center Energija d.o.o. (RCE) (Development Centre Energy d.o.o.), where the department researchers provide consulting and support work for technology development on the pilot and semi-industrial scale based on laboratory-test findings. The process scheme was developed and the laboratory plant constructed, which was used for optimisation of the self-designed gas injection nozzles and a successful 48-hour test was performed, followed by a 48-hour semi-industrial test at the premises of the partner company Esotech in Velenje.

The activity in the field of education and the promotion of sciences should be mentioned. Five co-workers were actively engaged in the work of the Jožef Stefan International Postgraduate School as lecturers and as mentors to M.Sc. and Ph.D. students. In addition, the School of Experimental Chemistry maintained its very important relations with elementary, secondary schools and even kindergartens through experimental courses performed in a specialised laboratory or through direct demonstrations at the schools. With demonstrations of chemical experiments we participated at the 19th Slovenian Science Festival, organized by the Slovenian Science Foundation and at the Researchers night in Ljubljana.

In the past year, we successfully completed the European project KidsINNscience, in which we have systematically gathered innovative practices in science education from each of the partner countries. We have a collection of 80 teaching practices for different levels of education. A total of 28 innovative practices were selected for transfer to educational institutions. Good innovative teaching practice helps to increase motivation and

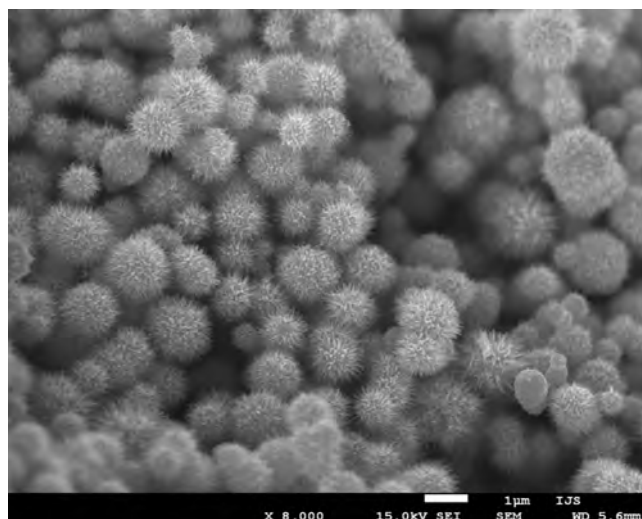


Figure 4: SEM image of a MoS₂ catalyst (foto: Gleb Veryasov)

We successfully concluded our work within the EU 7FP project iNTeg-Risk. One of the important goals of the project was the development, integration and demonstration of the proposed solutions for analysing and the management of emerging risks to society and industry.

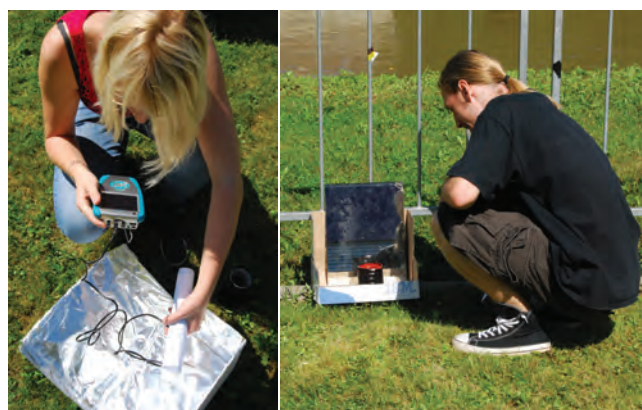


Figure 5: Innovative practice Cooking with the Sun originated from Spain. Students tried to build improvised devices, appropriate for cooking in a small bowl (foto: Matevž Kramer).

reduce disparities among students (boys/girls, children with special needs, etc.). It should be described clearly enough, but be flexible enough so that it can be used in different environments. Eight European countries: Austria (coordinator), Italy, Germany, the Netherlands, Spain, Switzerland, Great Britain and Slovenia, and two others, Brazil and Mexico, participated in the project.

Some outstanding publications in 2013

1. Shlyapnikov, I., Goreshnik, E. A., Mazej, Z.: The cubic $[\text{Ti}_8\text{F}_{36}]^{4-}$ anion found in the crystal structures of $\text{K}_4\text{Ti}_8\text{F}_{36}\cdot 8\text{HF}$ and $\text{Rb}_4\text{Ti}_8\text{F}_{36}\cdot 6\text{HF}$, Chem. Comm., 49 (2013), 2703–2705
2. Tavčar, G., Žemva, B.: $[\text{Li}(\text{XeF}_2)_n](\text{AF}_6)$ (A = P, As, Ru, Ir), the first xenon(II) compounds of lithium, Synthesis, Raman spectrum and crystal structure of $[\text{Li}(\text{XeF}_2)_3](\text{AsF}_6)$, Inorg. Chem., 52 (2013), 4319–4323
3. Kurzydłowski, D., Mazej, Z., Jagličič, Z., Filinchuk, Y., Grochala, W.: Structural transition and unusually strong antiferromagnetic superexchange coupling in perovskite KAgF_3 , Chem. Comm., 49 (2013), 6262–6264
4. Shlyapnikov, I., Mercier, H. P. A., Goreshnik, E. A., Schrobilgen, G. J., Mazej, Z.: Crystal structures and Raman spectra of imidazolium poly[perfluorotitanate(IV)] salts containing the $[\text{TiF}_6]^{2-}$, $([\text{Ti}_2\text{F}_9])_\infty$, and $[\text{Ti}_2\text{F}_{11}]^{3-}$ and the new $[\text{Ti}_4\text{F}_{20}]^{4-}$ and $[\text{Ti}_5\text{F}_{23}]^{3-}$ anions, Inorg. Chem., 52 (2013), 8315–8326
5. Stergaršek, A., Horvat, M., Frkal, P., Ribeiro Guevara, S., Kocjančič, R.: Removal of Hg^0 in wet FGD by catalytic oxidation with air - A contribution to the development of a process chemical model, Fuel, 107 (2013), 183–191

Patent granted

1. Andrej Kovič, Adolf Jesih, Aleš Mrzel, The procedure for the synthesis of 4d and 5d (Nb, Mo Ta, W) nitrites of transition metals in the form of quasi-one-dimensional structures, SI23988 (A), Urad RS za intelektualno lastnino, 30.8.2013.
2. Maja Remškar, Marko Viršek, Miha Kocmur, Adolf Jesih, Procedure for synthesis of threadlike tungsten oxide W5O14, US8496907 (B2), US Patent Office, 30.7.2013.

INTERNATIONAL PROJECTS

1. Export of the Fluorinated Carbons
Foreign Clients
Dr. Zoran Mazej
2. 7FP - iNTeg-Risk; Early Recognition, Monitoring and Integrated Management of Emerging, New Technology Related Risks
European Commission
Asst. Prof. Marko Gerbec
3. 7FP - KidsINNscience; Innovation in Science Education - Turning Kids on to Science
European Commission
Tomaž Ogrin, M. Sc.
4. 7FP - TOSCA; Total Operations Management for Safety Critical Activities
European Commission
Asst. Prof. Marko Gerbec
5. IPA ADRIATIC; ADRIACOLD - Diffusion of Cooling and Refresing Technologies using the Solar Energy resources in the Adriatic Regions
Consorzio per L'Area di Ricerca Scientifica
Asst. Prof. Gašper Tavčar
6. MED - EMILIE; Enhancing Mediterranean Initiatives Leading SMEs to Innovation in Building Energy Efficiency Technologies
Joint Technical Secretariat Med Programme
Asst. Prof. Gašper Tavčar
7. COST ES1006; Evaluation, Improvement and Guidance for the Use of Local-scale Emergency Prediction and Response Tools for Airborne Hazards in Built Environments
COST Office
Asst. Prof. Marko Gerbec
8. IPA ADRIATIC; ADRIACOLD - Diffusion of Cooling and Refresing Technologies Using the Solar Energy Resources in the Adriatic Regions

Ministry of Economic Development and Technology

Asst. Prof. Gašper Tavčar

9. Preparation of Agro-based Active Carbons by Phosphoric Acid Activation and their Application for Heavy Metal Removal and Improvement of Transition Metal Catalysts
Slovenian Research Agency
Dr. Adolf Jesih

RESEARCH PROGRAM

1. Inorganic Chemistry and Technology
Asst. Prof. Gašper Tavčar

R&D GRANTS AND CONTRACTS

1. Speciation and Interactions of Chemical Contaminants at Trace Level in Aqueous Media to Support the Development of Cost-effective Removal Technologies
Dr. Andrej Stergaršek

NEW CONTRACT

1. Fly ash CO₂ Fixation Methodology
RCE - Research Centre Energy, d. o. o.
Dr. Robert Kocjančič

VISITOR FROM ABROAD

1. Prof. Natalia Sikh, Valentyna Volynets, Institute for Sorption and Problems of Endoecology, NAS Ukraine, Kiev, Ukraine, 7. 10. -14. 10. 2013

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23. Mira Zupančič

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Bogdan Ardan, Yurii Slyvka, Evgeny A. Goreschnik, Marian G. Mys'kiv, "First N-allyl-aminothiazole copper(I) π -complexes: synthesis and structural peculiarities of $[\text{Cu}(\text{L})\text{CF}_3\text{SO}_3]$ and $[\text{Cu}_2(\text{L})_2(\text{H}_2\text{O})_2](\text{SiF}_6) \cdot 2.5\text{H}_2\text{O}$ compounds (L = 2-(allyl)-amino-5-methyl-1,3,4-thiadiazole)", *Acta chim. slov.*, vol. 60, no. 3, pp. 484-490, 2013.
2. Sebastian A. Baer, Matic Lozinšek, Florian Kraus, "Synthesis and crystal structure of triammine pentafluorido tantalum(V) $[\text{Ta}_5(\text{NH}_3)_3]$ ", *Z. anorg. allg. Chem. (1950)*, vol. 639, issue 14, pp. 2586-2588, 2013.
3. Mariana Derzsi, Armand Budzianowski, Viktor Struzhkin, Przemyslaw Malinowski, Piotr J. Leszczyński, Zoran Mazej, Wojciech Grochala, "Redetermination of crystal structure of $\text{Ag}(\text{II})\text{SO}_4$ and its high-pressure behavior up to 30 GPa", *CrystEngComm (Camb., Online)*, vol. 15, no. 1, pp. 192-198, 2013.
4. Cene Filipič, Gašper Tavčar, Evgeny A. Goreschnik, Boris Žemva, Adrijan Levstik, "Polarons in magnetoelectric fluorides", In: Proceedings of the 7th Seminar on Ferroelastic Physics, 10-13 September, 2012, Voronezh, Russia, *Ferroelectrics*, vol. 444, no. 1, pp. 190-198, 2013.
5. Marko Gerbec, "Supporting organizational learning by comparing activities and outcomes of the safety-management system", *J. loss prev. process ind.*, vol. 26, issue 6, pp. 1113-1127, 2013.
6. Evgeny A. Goreschnik, Gleb Veryasov, D. I. Morozov, Marian G. Mys'kiv, "Structural and vibrational analysis of copper(II) 1, 3-benzothiazol-2-yl[mimino(phenyl)methyl]azanide", *J. mol. struct.*, vol. 1038, pp. 200-205, 2013.
7. Dominik Kurzydłowski, Zoran Mazej, Wojciech Grochala, " Na_2AgF_4 : 1D antiferromagnet with unusually short $\text{Ag}^{2+} \dots \text{Ag}^{2+}$ separation", *Dalton trans. (2003. Print)*, vol. 42, no. 6, pp. 2167-2173, 2013.
8. Dominik Kurzydłowski, Zoran Mazej, Zvonko Jagličič, Yaroslav Filinchuk, Wojciech Grochala, "Structural transition and unusually strong antiferromagnetic superexchange coupling in perovskite KAgF_3 ", *Chem. commun. (Lond., 1996)*, vol. 49, no. 56, pp. 6262-6264, 2013.
9. Dmitry Peryshkov, Roland Friedemann, Evgeny A. Goreschnik, Zoran Mazej, Konrad Seppelt, Steven H. Strauss, "Anion packing, hole filling, and HF solvation in $\text{A}_2(\text{HF})_n\text{B}_{12}\text{F}_{12}$ and $\text{K}_2(\text{HF})\text{TiF}_6$ (A = K, Cs)", *J. fluorine chem.*, vol. 145, pp. 118-127, 2013.
10. Maja Ponikvar-Svet, Alecia T. Thomas, Bryan J. Dobson, Brittney M. Henegar, Mathew W. Brewster, Nagarak K. Neerchal, Joel F. Liebman, "Linear model for estimating the entropy of formation of aqueous anions", *Struct. chem.*, vol. 24, no. 6, pp. 2069-2082, 2013.
11. Igor Shlyapnikov, Evgeny A. Goreschnik, Zoran Mazej, "The cubic $[\text{Ti}_8\text{F}_36]^{4-}$ anion found in the crystal structures of $\text{K}_4\text{Ti}_8\text{F}_{36} \cdot 8\text{HF}$ and $\text{Rb}_4\text{Ti}_8\text{F}_{36} \cdot 6\text{HF}$ ", *Chem. commun. (Lond., 1996)*, vol. 49, no. 26, pp. 2703-2705, 2013.
12. Igor Shlyapnikov, H el ene P. A. Mercier, Evgeny A. Goreschnik, Gary J. Schrobilgen, Zoran Mazej, "Crystal structures and Raman spectra of imidazolium poly[perfluorotitanate(IV)] salts containing the $[\text{TiF}_6]^{2-}$, $([\text{Ti}_2\text{F}_9])^-$, and $[\text{Ti}_2\text{F}_{11}]^{3-}$ and the new $[\text{Ti}_4\text{F}_{20}]^{4-}$ and $[\text{Ti}_5\text{F}_{23}]^{3-}$ anions", *Inorg. chem.*, vol. 52, no. 15, pp. 8315-8326, 2013.
13. Yurii Slyvka, Evgeny A. Goreschnik, O. V. Pavlyuk, Marian G. Mys'kiv, "Copper(I) π -complexes with allyl derivatives of heterocyclic compounds: structural survey of their crystal engineering", *Cent. Eur. J. Chem.*, vol. 11, no. 12, 1875-1901, 2013.
14. Clara Sousa Silva, Gleb Veryasov, Evgeny A. Goreschnik, Maja Ponikvar-Svet, Adolf Jesih, "Crystal structure and vibrational spectra of hydrazinium(+1) fluorocadmate(II)", *Monatsh. Chem.*, vol. 144, no. 10, pp. 1455-1459, 2013.
15. Andrej Stergaršek, Milena Horvat, Peter Frkal, Sergio Ribeiro Guevara, Robert Kocjančič, "Removal of Hg^0 in wet FGD by catalytic oxidation with air - A contribution to the development of a process chemical model", *Fuel (Guildf.)*, vol. 107, pp. 183-191, 2013.
16. Satoshi Suzuki, Zoran Mazej, Boris Žemva, Yoshimi Ohzawa, Tsuyoshi Nakajima, "Surface passivation of natural graphite electrode for lithium ion battery by chlorine gas", *Acta chim. slov.*, vol. 60, no. 3, pp. 513-520, 2013.
17. A. Tadich, M. T. Edmonds, L. Ley, F. Fromm, Y. Smets, Zoran Mazej, J. Riley, C. I. Pakes, Th. Seyller, M. Wanke, "Tuning the charge carriers in epitaxial graphene on $\text{SiC}(0001)$ from electron to hole via molecular doping with $\text{C}_{60}\text{F}_{48}$ ", *Appl. phys. lett.*, vol. 102, no. 24, pp. 241601-1-241601-5, 2013.
18. Gašper Tavčar, Boris Žemva, " $[\text{Li}(\text{XeF}_2)_n](\text{AF}_6)$ (A = P, As, Ru, Ir), the first xenon(II) compounds of lithium. Synthesis, raman spectrum, and crystal structure of $[\text{Li}(\text{XeF}_2)_3](\text{AsF}_6)$ ", *Inorg. chem.*, vol. 52, issue 8, pp. 4319-4323, 2013.
19. Melita Tramšek, Evgeny A. Goreschnik, Gašper Tavčar, Zoran Mazej, "Synthesis and crystal structures of lanthanoid(III) hexafluoroarsenates with AsF_3 ligands", *Acta chim. slov.*, vol. 60, no. 3, pp. 537-542, 2013.
20. Andrii Vakulka, Evgeny A. Goreschnik, "Synthesis and characterization of 2CuCNDMSO and $[\text{Cu}^{\text{II}}(\text{DMSO})_6][\text{Cu}_2^{\text{I}}(\text{CN})_8]$ 3-D framework compounds", *Cent. Eur. J. Chem.*, vol. 11, no. 6, pp. 1001-1009, 2013.
21. Andrii Vakulka, Evgeny A. Goreschnik, Zvonko Jagličič, Zvonko Trontelj, "Synthesis, characterization and weak ferromagnetic coupling in $[\text{Cu}_2(\mu_3 - \text{CO}_3)(\text{SCN})_2(\text{py})_4]_n$ ", *Inorg. chem. commun.*, vol. 35, pp. 295-296, 2013.
22. Andrii Vakulka, Janez Kovač, Gašper Tavčar, Tomaž Skapin, "Fluorination of mixed γ -alumina/ γ -gallia xerogels with trifluoromethane: some effects on bulk and surface characteristics", *Acta chim. slov.*, vol. 60, no. 3, pp. 521-536, 2013.
23. Damjan Vengust, Boštjan Jančar, Andreja Šestan, Maja Ponikvar-Svet, Bojan Budič, Danilo Suvorov, "Chemical decomposition as a likely source of ambient and thermal instabilities of layered sodium cobaltate", *Chem. mater.*, vol. 25, no. 23, pp. 4791-4797, 2013.
24. Gleb Veryasov, Evgeny A. Goreschnik, Adolf Jesih, "Room temperature synthesis and crystal structure of mer- $[\text{MoBr}_3\text{Py}_3]$, the vibrational spectra of mer- $[\text{MoBr}_3\text{Py}_3]$, mer- $[\text{Mo}_3\text{Py}_3]$ and trans, trans- $[\text{MoBr}_2\text{Py}_4][\text{MoBr}_4\text{Py}_2]$ ", *Z. anorg. allg. Chem. (1950)*, vol. 639, issue 6, pp. 939-942, 2013.
25. Gleb Veryasov, Dmitriy Morozov, Evgeny A. Goreschnik, Adolf Jesih, "Synthesis and crystal structures of $(\text{pyH})_2[\text{Mo}_2\text{O}_4\text{F}_6]$ and (pipH_2)

[Mo₂O₄F₆]: vibrational band assignment for [Mo₂O₄F₆]²⁻ anion", *J. fluorine chem.*, vol. 156, str. 240-245, 2013.

REVIEW ARTICLE

1. Maja Ponikvar-Svet, Kathleen F. Edwards, Joel F. Liebman, "An overview of the understanding of ions containing solely fluorine atoms", *Acta chim. slov.*, vol. 60, no. 3, pp. 471-484, 2013.
2. Maja Ponikvar-Svet, Diana D. Zeiger, Loryn R. Keating, Joel F. Liebman, "Interplay of thermochemistry and Structural chemistry, the journal (volume 23, 2012, issues 4-6) and the discipline", *Struct. chem.*, vol. 24, no. 5, pp. 1759-1779, 2013.
3. Maja Ponikvar-Svet, Diana D. Zeiger, Loryn R. Keating, Joel F. Liebman, "Interplay of thermochemistry and Structural chemistry, the journal (volume 24, 2013, issues 1-2) and the discipline", *Struct. chem.*, vol. 24, no. 6, pp. 2101-2114, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Norbert Chilingarov, Igor Shlyapnikov, Zoran Mazej, A. E. Moiseev, Y. M. Shliapnikov, I. V. Ishtubaev, "The study of cerium tetrafluoride vaporization by Knudsen effusion mass spectrometry", In: *Workshop on Knudsen Effusion Mass Spectrometry, April 23-25, 2012, Juelich, Germany*, (ECS transactions, Vol. 46, 1, 2013), Pennington, Electrochemical Society, 2013, vol. 46, no. 1, pp. 191-195, 2013.
2. Marko Gerbec, Branko Kontić, "Key performance indicators and bayesian belief network based risk model as a management tool-results from the case study", In: *Safety, reliability and risk analysis: beyond the horizon*, European Safety and Reliability Conference, ESREL 2013, Amsterdam, The Netherlands, 29 September - 2 October 2013, R. D. J. M. Steenbergen, ed., Boca Raton [etc.], CRC Press, 2013, pp. 1859-1865.
3. Aleš Mrzel, Andrej Kovič, Adolf Jesih, Mojca Vilfan, "Decoration of MoSI nanowires with platinum nanoparticles and transformation into molybdenum-nanowire nased networks", In: *3rd International Conference Nanomaterials: Applications & Properties, 2013, NAP-2013, September 16-21, 2013, Alushta, the Crimea, Ukraine*, (Proceedings of the international conference nanomaterials, vol. 2, no. 2, 2013), Sumy, Sumy State University, 2013, vol. 2, no. 2, pp. 02PCN19-1-02PCN19-4, 2013.
4. Jože Pezdič, Ana R. Medved, Edi Burič, Antonija Lesar, Janja Žula, Lucija Petrinjak, Tine Pezdič, Robert Moravec, Gašper Tavčar, Simon Zavšek, "Improvements in high pressure sorption investigations of coal: case study of the Velenje lignite", In: *eProceedings*, 5th Jubilee Balkan Mining Congress, Ohrid, Macedonia, 18th-21st September 2013, Milan Medved, ed., Milivoj Vulić, ed., Jakob Likar, ed., Skopje, Association of mining and geological engineers of Macedonia, 2013, pp. 1-8.
5. Matej Sedlar, Majda Pavlin, Robert Kocjančič, Sani Bašič, Milena Horvat, "Development of the method for temperature fractionation of mercury in solid samples", In: *6th International Conference on Clean Coal Technologies*, 6th International Conference on Clean Coal Technologies, CCT2013, 12-16 May 2013, Thessaloniki, Greece, London, IEA Clean Coal Centre, 2013, 13 pp.
6. Gleb Veryasov, Miha Grilc, Blaž Likozar, Janez Levec, Adolf Jesih, "Unsupported MoS₂ catalysts for hydrodeoxygenation of liquefied

wood", In: *Slovenski kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, pp. [1-5].

7. Gleb Veryasov, Adolf Jesih, "Molybdenum coordination compounds as precursors for the preparation of Mo₂", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 70-76.
8. Gleb Veryasov, Dmitriy Morozov, Adolf Jesih, "Simulation of mer-[MoBr₃Py₃] Raman spectrum by DFT method", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 77-82.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Erhard Kemnitz, Tomaž Skapin, John M. Winfield, "Preparation of fluorinated γ -alimina", In: *Efficient preparations of fluorine compounds*, Herbert W. Roesky, ed., Hoboken, Wiley, 2013, pp. 442-447.

PATENT APPLICATION

1. Adolf Jesih, Andrej Kovič, Aleš Mrzel, *Method for a synthesis of quasi one-dimensional structures of 4D and 5D (Nb, Mo, Ta, W) transition metals*, WO2012177224 (A3), World Intellectual property organization, 21.2.2013.

PATENT

1. Andrej Kovič, Adolf Jesih, Aleš Mrzel, *The procedure for the synthesis of 4d and 5d (Nb, Mo Ta, W) nitrites of transition metals in the form of quasi-one-dimensional structures*, SI23988 (A), Urad RS za intelektualno lastnino, 30.8.2013.
2. Maja Remškar, Marko Viršek, Miha Kocmur, Adolf Jesih, *Procedure for synthesis of threadlike tungsten oxide W₅O₁₄*, US8496907 (B2), US Patent Office, 30.7.2013.

MENTORING

1. Matic Lozinšek, *Synthesis and characterisation of new compounds of weakly coordinating fluoro anions*: doctoral dissertation, Ljubljana, 2013 (mentor Boris Žemva).
2. Peter Frkal, *Removal of mercury from flue gas in wet desulphurization process*: master's thesis, Ljubljana, 2013 (mentor Marko Gerbec; co-mentor Milena Horvat).

DEPARTMENT OF PHYSICAL AND ORGANIC CHEMISTRY

K-3

The basic research of the department is focused on the experimental and theoretical study of various physico-chemical processes at surfaces and in atmospheric chemistry. The main attention in the field of organic chemistry is directed to the halogenated, in particular fluorinated, organic molecules.

Experimental research in the field of electrochemistry is oriented to various types of corrosion protection – from surface layers to functional modifications of the surface and corrosion inhibitors. The materials of interest are used in technological and biomedical applications. Within the project Surfuncti financed by the European Research Area (ERA) we have investigated a novel alloy for the biomedical applications, Ti-20Nb-10Zr-5Ta. This alloy exhibits better mechanical properties, i.e., a lower elastic modulus and higher hardness, than commercial titanium alloys. At the same time it is more corrosion protective under simulated physiological conditions. The composition of the layer changes depending on the potential and contains sub-oxides and oxides of all the alloy components. At more negative potentials the layer contains a mixture of sub-oxides (Ti_2O_3 , NbO/NbO_2 , TaO/TaO_2) and oxides (TiO_2 , Nb_2O_5 , ZrO_2 , Ta_2O_5), with titanium oxide being the predominant oxide. With the increasing electrode potential the content of sub-oxides decreases and the highest valence oxide prevails. Compared to other elements, the oxidation of tantalum is inhibited. While other alloying elements are almost completely transformed to the highest valence oxide, i.e., TiO_2 , Nb_2O_5 and ZrO_2 , tantalum remains mainly in the metal and sub-oxide, TaO/TaO_2 , forms. Thus, the formation of the pentoxide Ta_2O_5 as the highest valence oxide is suppressed compared to the oxides of other alloying elements. Metal cations of alloying components in the form of oxides are enriched in the layer relative to the metal content in the bulk alloy. It is hypothesized that this is the main reason for the exceptional protectiveness of the passive layer formed on the Ti-20Nb-10Zr-5Ta alloy. The long-term effects of an alloy implanted in the recipient's body were investigated in a minimum essential medium (MEM), using two types of human cells – an osteoblast-like cell line (HOS) and immortalized pulmonary fibroblasts (Wi-38). In terms of biocompatibility, the novel alloy performs similar to titanium. The project was performed in collaboration with the Institute of Physical Chemistry "Ilie Murgulescu" from Bucharest and the Faculty of Health Sciences University of Primorska.

The research also continued on commercial biomedical alloys. The formation of the oxide layer on Ti-based materials – Ti metal and Ti-6Al-7Nb and NiTi alloys – in acetic acid was studied at two potentials of interest, 0.7 V and 3.0 V. Regardless of the substrate, the main oxide component formed was titanium(IV) oxide, TiO_2 . The layer formed on the Ti-6Al-7Nb alloy contained oxides of minor elements, Al_2O_3 and Nb_2O_5 , while the layer formed on Nitinol contained a small amount of nickel. The composition of the oxide layer is similar on all three substrates, but its thickness differs according to the oxidation potential and type of substrate. The thickness increases in the following order as a function of substrate: NiTi < Ti-6Al-7Nb < Ti. Anodization in acetic acid, and the resulting formation of TiO_2 at the substrate, beneficially affects the corrosion behavior of all three materials in a simulated physiological solution. Similar treatment, i.e., anodic oxidation in sodium hydroxide, was used for the corrosion protection of biodegradable magnesium alloys. The corrosion rate of this material is so high that its degradation may occur before the end of the healing process. An oxide film formed by anodic oxidation reduced the corrosion rate and slowed down the dissolution of magnesium, as proved by complexometric titration.

Metallic materials used for the manufacture of dental implants have to exhibit a high corrosion resistance in order to prevent metal release.



Head:
Prof. Ingrid Milošev

A new hybrid coating for the corrosion protection of metals in various corrosive media was developed. This coating is an alternative to the traditionally most successfully used chromate coatings; their use is today restricted due to toxicity and carcinogenicity. This achievement was included in the international programme Bastille LCC and resulted in a patent application filed in the USA in 2013.

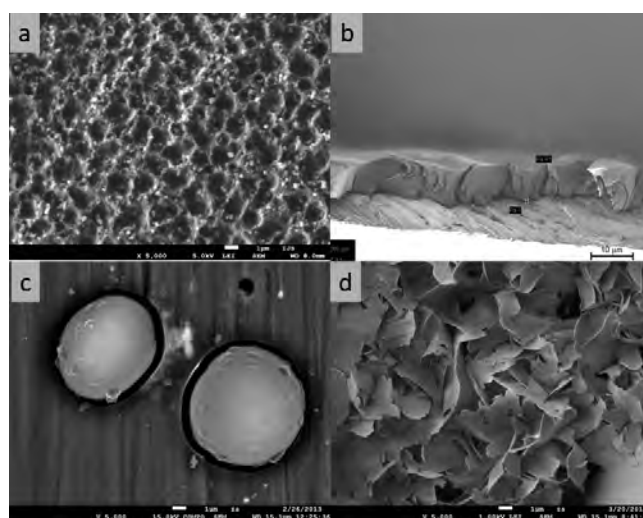


Figure 1: Various types of corrosion protection developed in our laboratory: (a) formation of a protection anodic layer on a magnesium alloy by anodic oxidation in NaOH, (b) synthesis of hybrid sol-gel coating on an aluminium alloy, (c) formation of conversion coating based on lanthanum nitrate on the intermetallics on aluminium alloy, and (d) formation of self-assembled layer of stearic acid on copper.

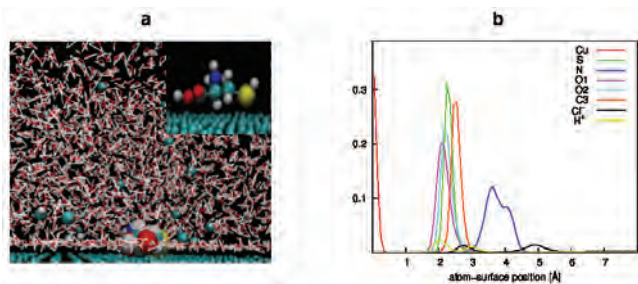


Figure 2: Adsorption configuration (a) and normalized histograms of atomic positions relative to Cu(111) surface (b) for cysteine molecule in an acid medium. In insets the medium is excluded to present more clearly the adsorption configurations of the molecules at the Cu(111) surface (turquoise). Legend: amino acid: O (red), N (blue), S (yellow), C (green), H (grey); medium: H₂O (white), H₃O⁺ (red), Cl (green).

beneficial properties aluminium and its alloys are used in numerous applications in civil engineering, automotive and aerospace industry, food and electronic industry. These materials exhibit low density, high tensile strength, excellent thermal and electrical conductivity and high strength-to-weight ratio. For many decades the chromate coatings represented the most effective corrosion protection of aluminium alloys. Since their production implies

Our co-worker dr. A. Kokalj is ranked as the most cited scientist in the field of Chemistry (source: SICRIS). Among the top twenty most cited authors, there are three co-workers from our department.

The oral cavity is aggressive towards metals as it represents a multivariate environment with a wide range of conditions, including temperature, pH, the presence of bacteria and the effect of abrasion. An increasing use of various Ti-based materials for dental implants and orthodontic brackets poses the question of their corrosion resistance in the presence of fluoride ions, which are added to toothpaste and mouth rinse. The corrosion behaviour of Ti metal, Ti-6Al-7Nb and Ti-6Al-4V alloys investigated in artificial saliva was significantly affected by the presence of fluoride ions. The layer formed was less protective than that formed in a fluoride-free solution. At the surface, calcium fluoride and/or sodium and potassium hexafluorotitanate and hexafluoroaluminate were formed.

Among materials important for use in industry we have studied the corrosion protection of alloys based on aluminium, copper and zinc. The formation of various coatings on the surface of metals and alloys is one way of corrosion protection for technologically important materials. Due to their beneficial properties aluminium and its alloys are used in numerous applications in civil engineering, automotive and aerospace industry. These materials exhibit low density, high tensile strength, excellent thermal and electrical conductivity and high strength-to-weight ratio. For many decades the chromate coatings represented the most effective corrosion protection of aluminium alloys. Since their production implies the use of toxic compounds, the use of chromate coatings was banned or restricted in 2002 by European regulations. Today, new alternatives for chromate coatings are investigated, which would achieve comparable corrosion protection while being environmentally acceptable. In that context the development of sol-gel coatings is important. In our laboratory we are devoted to the development of hybrid sol-gel coatings that enable effective corrosion protection of aluminium and its alloys (AA2024 and AA7075).

Hybrid coatings developed in the laboratory were awarded as best innovative project at the Sixth International Technology Transfer Conference & Innovation Day 2013. This innovation was included in programme Bastille LCC and the patent application was filed in the USA.

Lanthanoid salts are also considered as a potential replacement for toxic and carcinogenic chromate coatings. The effectiveness of inhibition increases in the following order: CeCl₃, La(NO₃)₃, LaCl₃, Ce(NO₃)₃ in Nd(NO₃)₃. CeCl₃ acts as a cathodic inhibitor, while other salts act as mixed cathodic/anodic inhibitors. An important result

was that a mixture of salt has a synergetic effect. Conversion coatings were prepared at different times of immersion and different temperatures. At room temperature the most effective protection was achieved by Ce(NO₃)₃ coatings. At higher temperature, 60 °C, conversion coatings based on La(NO₃)₃ and Ce(NO₃)₃ exhibited better protection. The mechanism of inhibitions was dependent on the type of inhibitor. The Ce(NO₃)₃ coating is formed at the whole surface, while La(NO₃)₃ and Nd(NO₃)₃ coatings are formed at the intermetallic sites of copper and zinc.

Investigations of natural compounds as potentials inhibitors of the corrosion of metals open new possibilities for the elimination of toxic and hazardous organic inhibitors. Among these so-called green inhibitors we have investigated phytic acid or inositol hexakisphosphate (IP₆). It is found in natural plants, especially seeds and bran. Self-assembled monolayers are liable to form dense and stable films on the surface, which can protect the metal against the corrosion process. The corrosion resistance in a 3% NaCl solution was studied by electrochemical measurements as a function of the preparation method, including surface roughening, time of immersion and inhibitor concentration. The results indicate that the most effective pretreatment was the oxidation-reduction cycle in 2-M H₂SO₄ which increased the roughness of the copper surface and its contact angles. The best corrosion effectiveness was achieved at a concentration of phytic acid of 0.1 mM and an optimum immersion time of 6 hours. Self-assembled layers of phytic acid can be used as a cheap, non-toxic inhibitor against the corrosion of copper in chloride solution reaching inhibitor effectiveness around 80 % under optimal conditions. X-ray photoelectron analysis proved that IP₆ chemically bonds to the metal surface. Within the search of environmental friendly inhibitors the carboxylic acids were also tested for the corrosion of copper, zinc and brasses in artificial rain. The carboxylic acids form by self-assembling a hydrophobic layer on the surface which improves the corrosion resistance of underlying metals. The surface of metals was modified by immersing the samples in ethanol solution of different carboxylic acids: hexanoic, decanoic, myristic and stearic. The corrosion resistance increases with the length of the aliphatic tail of carboxylic acid.

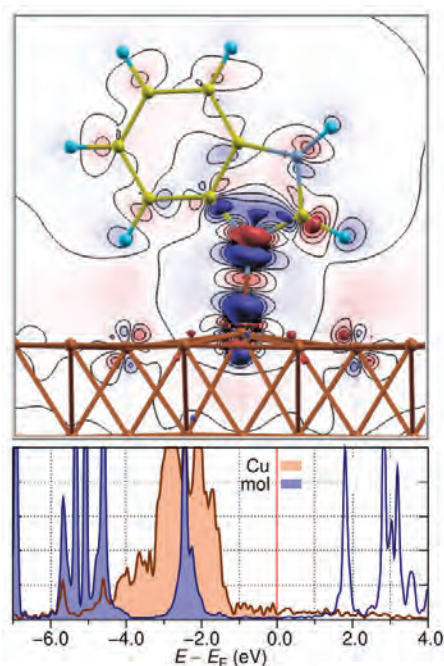


Figure 3: Electronic structure of benzimidazole molecule interacting with Cu(111) surface: charge density difference (top) and molecule and Cu projected density of states (bottom).

We investigated the influence of surface roughness on the formation of hydrophobic layer and corrosion resistance. For a given carboxylic acid, samples with higher surface roughness have better corrosion resistance. The process of self-assembling is fast, as corrosion protection was achieved after only one minute of immersion in an inhibitor solution. Myristic and stearic acids exhibited over 95 % inhibition effectiveness on copper and brass. For zinc these acids were less effective (about 60 %).

Experimental electrochemical methods combined with quantum chemical calculations and molecular dynamics simulations were used to investigate the possibility of exploring various amino acids as “green” corrosion inhibitors for copper in hydrochloric acid. Among eleven amino acids studied, cysteine achieved the highest inhibitor effectiveness reaching 52% at 10-mM concentration. Other amino acids reached an effectiveness less than 25%, some of them even acted as corrosion accelerators. Based on the experimental results, theoretical calculations and simulations were focused on cysteine and alanine. The electronic and reactivity parameters of their protonated forms in an electrical double layer were evaluated by density functional calculations. In addition, molecular dynamic simulations were introduced to follow the adsorption behaviour of these two amino acids at the Cu(111) surface in the electrolyte solution. The results indicate that the orientation of both molecules is nearly parallel to the surface, except that of the ammonium group, which is directed away from the surface. Therefore, as the orientation of the cysteine and alanine molecules at the surface is similar, the thiol functional group is responsible for the superior inhibition efficiency of cysteine.

We continued with the study of organic corrosion inhibitors (i.e., molecules that have the ability to inhibit the corrosion). Our principal aim is to better understand how organic corrosion inhibitors act against corrosion at the molecular level and to discern the fundamental principles that govern their corrosion inhibition characteristics. In the past few years we have studied by means of first-principle density-functional-theory (DFT) based computer simulations the interaction of several azole type corrosion inhibitors with surfaces of copper, iron, and aluminium. Our findings indicate that the inhibitor-surface bonding strongly depends on the type of metal. Due to obvious modelling reasons the majority of DFT calculations were performed at the solid/vacuum interface. Nevertheless, we have recently extended these calculations and also considered the solid/liquid interface, because corrosion takes place at this phase boundary. In this context, we examined the interaction of imidazole, triazole, and tetrazole inhibitors with surfaces of copper. Molecules in protonated, neutral, and deprotonated forms were considered so as to ascertain how the molecule-surface interaction depends on the »acid-base« molecular form. We have shown that chemisorptive bonding is the strongest for deprotonated inhibitors. This preference is particularly strong for triazole and tetrazole, while for imidazole the aqueous-phase adsorption free energy of the neutral form is comparable to that of deprotonated form. This suggests that for imidazole – because of its more basic nature – the neutral form and for triazole and tetrazole their deprotonated forms are the active species for inhibiting corrosion.

With respect to a long-term goal of developing more predictive models for screening new corrosion inhibitors with potentially superior corrosion inhibition characteristics, we were able – on the basis of the ascertained atomic scale details of the inhibitor-surface interactions – to pinpoint some inconsistencies in the usual application of a few electronic parameters that are frequently used in this context and are based on the so-called HSAB (*hard and soft acids and bases*) concept. Theoretical formalization of the HSAB concept has been derived for molecular systems, yet in the context of corrosion inhibitors one deals with surfaces that are extended systems. This leads to some ambiguities, which are the source of the above-mentioned inconsistencies. We have shown how these HSAB-based electronic parameters can be consistently applied in the case molecular-surface systems.

Our theoretical investigations of atmospherically relevant radical reactions were based on quantum chemical methods and in this year were focused on the examination of the mechanism of the singlet radical-radical reaction of the CH_2ClO_2 with NO. The chlorine-containing peroxy radical CH_2ClO_2 appears in the atmosphere as an intermediate in the oxidation of methyl chloride originating from oceans, volcano eruptions and vegetation burning. In general, the mechanism can be summarized as the initial association of radicals, followed by isomerization and/or the dissociation of intermediates. The association by forming the N-O bond is an energetically

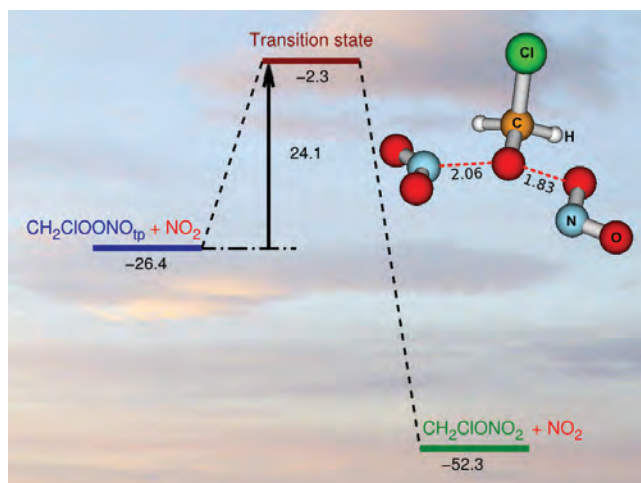


Figure 4: NO_2 -assisted nitrite-nitrate isomerisation transition state.

By means of first-principle density-functional-theory-based computer simulations we have ascertained many details about the interaction of azole corrosion inhibitor molecules with the surfaces of various types of metals, which is now much better understood at the atomic level.

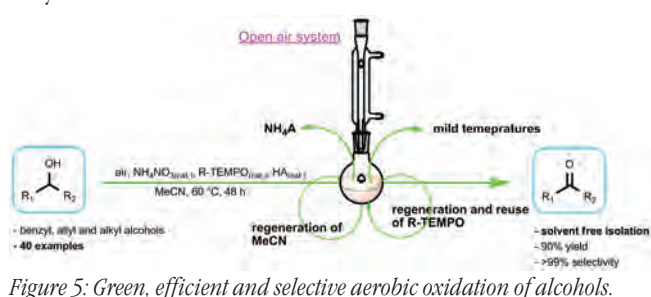


Figure 5: Green, efficient and selective aerobic oxidation of alcohols.

favorable process occurring without barrier. The CH_2ClONO intermediate possesses two conformational forms, the very low rotational barrier makes their interconversion likely. While the only pathway for the cis-perp CH_2ClONO is homolytic dissociation to form the $\text{CH}_2\text{ClO} + \text{NO}_2$ products, the trans-perp CH_2ClONO is also open for the rearrangement to nitrate. The barrier for rearrangement that must be surmounted is very high, but it has been shown that one NO_2 molecule stabilizes the transition state for nitrite-nitrate transformation. NO_2 -assisted isomerization reduces the activation energy significantly, being below the free reactants energy level, implying that the nitrite-nitrate isomerization process would be possible. The subsequent decomposition of $\text{CH}_2\text{ClONO}_2$ results in three reaction channels. The lower energy channel is the elimination of nitrous acid with the simultaneous production of CHClO , while the elimination of formaldehyde accompanying with the formation of either c- ClONO or ClNO_2 products is somewhat less favorable.

In the framework of the Laboratory for Organic and Bio-organic Chemistry we continued the investigation on the application of the principles of green chemistry to the transformations of organic compounds. We developed

We have demonstrated that the nitrite-nitrate isomerization in the CH_2ClO_2 radical reaction with NO is significantly facilitated by the assistance of a single NO_2 molecule compared to the unimolecular isomerization.

a green, efficient and selective method for the oxidation of alcohols to corresponding carbonyl derivatives using air oxygen under the catalytic support of a three-component system: *ammonium nitrate / nitroxyl radical / strong acid*. The method was verified on the broad selection of different structural types of alcohols, including those bearing heteroatoms. The scale-up experiment was performed, revealing the potential convenience also for industrial application. On the basis of this knowledge we invented and

developed a new method for the aerobic chlorination of organic compounds using the reaction system: *air / ammonium nitrate (cat) / molecular iodine (cat) / 36% aqueous HCl* and established its efficiency and selectivity in the case of the transformation of methyl ketone derivatives in their chloromethyl analogues. Each component of the reaction system was found to be essential for its efficiency. We proved that the first step of the reaction is aerobic iodination, catalysed by the redox cycle of nitrogen oxides, followed by a halogen-exchange process and the oxidative regeneration of released iodide so continuing the process. We further investigated the use of polyvalent iodine compounds as iodinating reagents and invented a new method for the catalytically supported oxidation of iodine in iodine(I) compounds using hydrogen peroxide or oxygen and the application of these compounds for the iodination of organic compounds, thus overcoming the low reactivity of molecular iodine and increasing the green profile of the iodination process.

We investigated the transformations of alcohols with N-halosuccinimides in aqueous media or under solvent-free reaction conditions. Tertiary benzyl alcohols could be directly transformed to vicinal halohydrines in aqueous media

We have developed a green, efficient and selective method for the oxidation of alcohols to the corresponding carbonyl derivatives using air oxygen under the catalytic support of a three-component system: *ammonium nitrate / nitroxyl radical / strong acid*.

or in vicinal halo-methoxy derivatives in methanol solvent. We discovered that N-halo compounds could be efficient catalysts for transformations of primary, secondary and tertiary benzyl alcohols into the corresponding derivatives, where the hydroxyl group is directly substituted with a different nucleophile.

In the framework of the syntheses of organic peroxides as potential bioactive compounds we were continuing the investigation of an efficient transformation of different substrates to structurally varied model organic peroxides and tested antibacterial bioactivity.

In the framework of the Centre of Excellence CIPKeBiP and the collaboration of the high-tech company ACIES BIO we were continuing investigations of the directed synthesis of potential bioactive compounds from the family of pantothenic acid and derivatives of maleic acid as precursors in polyketide biosynthesis. We have continued the collaboration with the company Semenarna on the synthesis of gamethocydic active compounds used in the processes of the production of plant hybrids and with the company ECOT in the development of new products used in non-human cosmetics. At the Jožef Stefan International Postgraduate School we teach two organic green-chemistry courses.

Some outstanding publications in the past year

1. Milošev, I., Žerjav, G., Calderon Moreno, J. M., Popa, M.: Electrochemical properties, chemical composition and thickness of passive film formed on novel Ti-20Nb-10Zr-5Ta alloy, *Electrochim. Acta*, 99 (2013), 176–189
2. Milošev, I., Blejan, D., Varvara, S., Muresan, L. M.: Effect of anodic oxidation on the corrosion behaviour of Ti-based materials in simulated physiological solution, *J. Appl. Electrochem.*, 43 (2013), 645–658
3. Kovačević, N., Kokalj, A.: Chemistry of the interaction between azole type corrosion inhibitor molecules and metal surfaces, *Mater. Chem. Phys.*, 137 (2012), 331–339
4. Lesar, A.: Mechanistic study on the reaction of the CH_2ClO_2 radical with NO, *Chem. Phys. Lett.*, 579 (2013), 28–34

5. R. Prebil, Laali, K. K., S. Stavber, Metal and H₂O₂ free aerobic oxidative aromatic halogenation with [RNH₃⁺][NO₃⁻]/HX and [BMIM(SO₃H)][(NO₃)_x(X)_y] (X = Br, Cl) as multifunctional ionic liquids. *Org. Lett.*, 15 (2013), 2108–2111
6. Bedrač, L., Iskra, J.: Iodine(I) reagents in hydrochloric acid-catalyzed oxidative iodination of aromatic compounds by hydrogen peroxide and iodine, *Advanced Synthesis & Catalysis*, 355 (2013), 1243–1248

Awards and appointments

1. Leon Bedrač: Krka Awards for PhD Thesis, Novo mesto, Slovenia, 2013
2. Sebastjan Peljhan: Maks Samec Awards for PhD Thesis in the field of Chemistry, Ljubljana, Slovenia, 2013
3. Peter Rodič, Ingrid Milošev, Jernej Iskra, Barbara Kapun: 1st prize at the 6th International Conference for technology transfer together with Innovation Day of the Chamber of Commerce of Slovenia for innovation with largest market potential after the selection of local and foreign experts in the field of technology transfer and representatives of domestic and foreign venture capital, 2013

Organization of conferences, congresses and meetings

1. Fourth Regional Symposium on Electrochemistry, South-East Europe - RSE-SEE, Ljubljana, Slovenia, 26. 5.–30. 5. 2013

Patent granted

1. Primož Titan, Jernej Iskra, Vladimir Meglič, Chemical hybridization of hermaphrodite plant species with easily soluble derivatives of oxanilic acid, SI24033 (A), Urad RS za intelektualno lastnino, 30.10.2013.

INTERNATIONAL PROJECTS

1. CARISMA; Catalytic Routines for Small Molecule Activation
COST Office
Asst. Prof. Jernej Iskra
2. Transformations of Organic Compounds under Green Reaction Conditions
Slovenian Research Agency
Prof. Stojan Stavber
3. Improvement of Functionality of Biomedical and Engineering Materials
Slovenian Research Agency
Prof. Ingrid Milošev

2. Use of Green Energy Sources: New Functional Nanomaterials on the Base of Polyoxometalates and TiO₂ Nanostructures for Production of Hydrogen by Catalytic Oxidation of Water -NANOleaf
Asst. Prof. Jernej Iskra
3. New Technology for Design of Novel Polyketide Drug-Leads with Chemically Amenable Moieties
Prof. Stojan Stavber
4. SURFUNCTI: Controlled Surface Structuring and Surface Functionalisation of Advanced Biomedical Titanium Alloys for Orthopaedic Implants
Prof. Ingrid Milošev

RESEARCH PROGRAMS

1. Multiphase Nanoarchitectures: Development, Physical-Chemical Characterization and Simulation of Processes
Prof. Ingrid Milošev
2. Bioorganic and Bioorganic Chemistry
Prof. Stojan Stavber

NEW CONTRACTS

1. Development of New Synthetic Protocols
Acies Bio, d. o. o.
Prof. Stojan Stavber
2. New Technology for Design of Novel Polyketide Drug-Leads with Chemically Amenable Moieties
Acies Bio, d. o. o.
Prof. Stojan Stavber

R&D GRANTS AND CONTRACTS

1. Modifications of Surface of Metallic Biomaterials and Their Interaction with Bio-Environment
Prof. Ingrid Milošev

VISITORS FROM ABROAD

1. Selma Özarlan, Ph. D. Student, Mustafa Kemal University, Science and Art Faculty, Department of Physics, Antaky - Hatay, Turkey, 18. 3.–23. 9. 2013
2. Prof. Osman Sahin, Mustafa Kemal University, Science and Art Faculty, Department of Physics, Antaky - Hatay, Turkey, 5. 6. 2013
3. Prof. Silvia Cere, INTEMA, Division of Electrochemistry and Corrosion, Universidad Nacional de Mar del Plata, Argentina, 24. 6.–6. 7. 2013

STAFF

Researchers

1. Asst. Prof. Jernej Iskra
2. Dr. Anton Kokalj
3. Dr. Antonija Lesar
4. **Prof. Ingrid Milošev, Head**
5. Prof. Stojan Stavber

Postgraduates

6. Dr. Leon Bedrač, left 01.09.13
7. Dr. Nataša Kovačević, left 01.07.13
8. Jerca Pahor, B. Sc.

9. Dunja Peca, B. Sc.
10. Rok Prebil, B. Sc.
11. Peter Rodič, B. Sc.
12. Katarina Starkl, B. Sc.
13. Simona Tušar, B. Sc.
14. Barbara Volarič, B. Sc.
15. Dr. Dejan Vražič, left 01.04.13
16. Gregor Žerjav, B. Sc.

Technical officer

17. Barbara Kapun, B. Sc.

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Leon Bedrač, Jernej Iskra, "Iodine(I) reagents in hydrochloric acid-catalyzed oxidative iodination of aromatic compounds by hydrogen peroxide and iodine", *Advanced Synthesis & Catalysis*, vol. 355, no. 7, pp. 1243-1248, 2013.
2. Jernej Iskra, Primož Titan, Vladimir Meglič, "The effect of fluorine atom on the synthesis and composition of gametocidal ethyl oxanilates", *Acta chim. slov.*, vol. 60, no. 3, pp. 561-568, 2013.
3. Marjan Jereb, Dejan Vražič, "Iodine-catalyzed disproportionation of aryl-substituted ethers under solvent-free reaction conditions", *Organic and Biomolecular Chemistry*, vol. 11, no. 12, pp. 1978-1999, 2013.
4. Darja Kek-Merl, Peter Panjan, Ingrid Milošev, "Effect of tungsten content on properties of PVD sputtered Al-W_x alloys", *Surf. eng.*, vol. 29, no. 4, pp. 281-286, 2013.
5. Anton Kokalj, "Comments on the paper 'On the nature of inhibition performance of imidazole on iron surface' by J.O. Mendes, E.C. da Silva, A.B. Rocha", *Corros. sci.*, vol. 68, pp. 286-289, 2013.
6. Anton Kokalj, "Comments on the 'Reply to comments on the paper 'On the nature of inhibition performance of imidazole on iron surface'' by J.O. Mendes and A.B. Rocha", *Corros. sci.*, vol. 70, pp. 294-297, 2013.
7. Anton Kokalj, "Formation and structure of inhibitive molecular film of imidazole on iron surface", *Corros. sci.*, vol. 68, pp. 195-203, 2013.
8. Nataša Kovačević, Anton Kokalj, "The relation between adsorption bonding and corrosion inhibition of azole molecules on copper", *Corros. sci.*, vol. 73, pp. 7-17, 2013.
9. Antonija Lesar, "Mechanistic study on the reaction of the CH₂ClO₂ radical with NO", *Chem. Phys. Lett.*, vol. 579, pp. 28-34, 2013.
10. Ingrid Milošev, Diana Blejan, Simona Varvara, Liana-Maria Muresan Muresan, "Effect of anodic oxidation on the corrosion behavior of Ti-based materials in simulated physiological solution", *J. Appl. Electrochem.*, vol. 43, no. 7, pp. 645-658, 2013.
11. Ingrid Milošev, Julija Hmeljak, Andrej Cör, "Hyaluronic acid stimulates the formation of calcium phosphate on CoCrMo alloy in simulated physiological solution", *J. mater. sci., Mater. med.*, vol. 24, no. 3, pp. 555-571, 2013.
12. Ingrid Milošev, Barbara Kapun, Vid Simon Šelih, "The effect of fluoride ions on the corrosion behaviour of Ti metal, and Ti6Al7Nb and Ti6Al4V alloys in artificial saliva", *Acta chim. slov.*, vol. 60, no. 3, pp. 543-555, 2013.
13. Ingrid Milošev, Jasminka Pavlinac, Milan Hodošek, Antonija Lesar, "Amino acids as corrosion inhibitors for copper in acidimedium: experimental and theoretical study", *J. Serb. Chem. Soc.*, vol. 78, no. 12, pp. 2069-2086, 2013.
14. Ingrid Milošev, Gregor Žerjav, Jose Maria Calderon Moreno, Monica Popa, "Electrochemical properties, chemical composition and thickness of passive film formed on novel Ti20Nb10Zr5Ta alloy", *Electrochim. acta*, vol. 99, pp. 176-189, 2013.
15. Igor Pravst, Stojan Stavber, "Fluorination of 4-alkyl - substituted phenols and aromatic ethers with fluoroxy and N-F reagents: caesium fluoroxy sulfate and N-fluoro-1,4-diazonia-bicyclo[2.2.2]octane dication salts case", *J. fluorine chem.*, vol. 156, pp. 276-282, 2013.
16. Rok Prebil, Kenneth K. Laali, Stojan Stavber, "Metal and H₂O₂ free aerobic oxidative aromatic halogenation with [RNH₃⁺][NO₃⁻]/HX and

[BMIM(SO₃H)][NO₃]_x(X)_y] (X = Br, Cl) as multifunctional ionic liquids", *Org. lett.*, vol. 15, no. 9, pp. 2108-2111, 2013.

17. Peter Rodič, Marsel Bratuša, Miha Lukšič, Vojko Vlady, Barbara Hribar, "Influence of the hydrophobic groups and the nature of counterions on ion-binding in aliphatic ionene solutions", *Colloids surf., A Physicochem. eng. asp.*, vol. 424, no. 1, pp. 18-25, 2013.
18. Matevž Topolovec, Ingrid Milošev, Andrej Cör, Roy D. Bloebaum, "Wear debris from hip prostheses characterized by electron imaging", *Cent. Eur. J. Med.*, vol. 8, no. 4, pp. 476-484, 2013.
19. Dejan Vražič, Marjan Jereb, Kenneth K. Laali, Stojan Stavber, "Brønsted acidic ionic liquid accelerated halogenation of organic compounds with N-halosuccinimides (NXS)", *Molecules (Basel)*, vol. 18, no. 1, pp. 74-96, 2013.

REVIEW ARTICLE

1. Katarina Starkl, Janez Mravljak, "Zdravljenje in preprečevanje malarije", *Farm. vestn.*, vol. 64, no. 5, pp. 371-379, dec. 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Njomza Ajvazi, Stojan Stavber, "Transformations of alcohols mediated by N-halosuccinimides: reactions in solution or under solvent-free conditions", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 239-249.
2. Tatsuo Matsushima, Hideo Orita, Anton Kokalj, "An experimental approach to transition states of surface reactions: energy partitioning in repulsive desorption", In: *Proceedings of the SSSJ 32, 32th Symposium of Surface Science of Japan, 2012*, (E-Journal of surface science and nanotechnology, vol. 11, 2013), Tokyo, Surface Science Society of Japan, 2013, vol. 11, pp. 65-71, 2013.
3. Jože Pezdič, Ana R. Medved, Edi Burič, Antonija Lesar, Janja Žula, Lucija Petrinjak, Tine Pezdič, Robert Moravec, Gašper Tavčar, Simon Zavšek, "Improvements in high pressure sorption investigations of coal: case study of the Velenje lignite", In: *eProceedings*, 5th Jubilee Balkan Mining Congress, Ohrid, Macedonia, 18th-21st September 2013, Milan Medved, ed., Milivoj Vulič, ed., Jakob Likar, ed., Skopje, Association of mining and geological engineers of Macedonia, 2013, pp. 1-8.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Andrej Cör, Julija Hmeljak, Mitja Rak, Maja Čemažar, Ingrid Milošev, "Pathophysiological mechanisms of joint impant loosening", In: *The Partners and the Objectives of the Trans2Care, and Italy-Slovenia cross-border network of science and healthcare institutions*, Sabina Passamonti, ed., Trieste, Edizioni Università di Trieste, 2013, pp. 99-102.
2. Ingrid Milošev, Vesna Levašič, Andrej Cör, Venčeslav Pišot, "Mechanical, biological, material and clinical aspects of performance of joint

prostheses", In: *The Partners and the Objectives of the Trans2Care, and Italy-Slovenia cross-border network of science and healthcare institutions*, Sabina Passamonti, ed., Trieste, Edizioni Università di Trieste, 2013, pp. 105-108.

3. A. Somasekar Rao, H. Rama Mohan, Jernej Iskra, "Hydrogen peroxide", In: *Handbook of reagents for organic synthesis, Catalytic oxidation reagents*, (Handbook for reagents for organic synthesis series), Philip L. Fuchs, ed., Chichester, New York, Wiley, cop. 2013, pp. 284-295.
4. Y. Takakubo, Aleš Berce, Rihard Trebše, Y. Tamaki, Ingrid Milošev, A. Al-Samadi, Veli-Matti Tiainen, Y.T. Kontinen, "Wear and corrosion in the loosening of total joint replacements (TJR)", In: *Bio-tribocorrosion in biomaterials and medical implants*, (Woodhead publishing series in biomaterial, 60), Yan Yu, ed., Cambridge, Woodhead Publishing Limited, 2013, pp. 74-110.

PATENT APPLICATION

1. Peter Rodič, Ingrid Milošev, *Hybrid sol-gel compositions and corrosion-resistant coatings based upon same*, US61/842.025, US Patent Office, 2.7.2013.
2. Primož Titan, Jernej Iskra, Vladimir Meglič, *Chemical hybridization of hermaphrodite plant species with easily soluble derivatives of oxanilic*

acid, WO2013162479 (A1), World Intellectual property organization, 31.10.2013.

PATENT

1. Primož Titan, Jernej Iskra, Vladimir Meglič, *Chemical hybridization of hermaphrodite plant species with easily soluble derivatives of oxanilic acid*, SI24033 (A), Urad RS za intelektualno lastnino, 30.10.2013.

MENTORING

1. Leon Bedrač, *Iodine(I) compounds: catalysts for iodination of organic molecules*: doctoral dissertation, Ljubljana, 2013 (mentor Jernej Iskra).
2. Nataša Kovačević, *Interactions ofazole corrosion inhibitors with transition metal surfaces*: doctoral dissertation, Ljubljana, 2013 (mentor Anton Kokalj; co-mentor Ksenija Kogej).
3. Dejan Vražič, *The Role of Iodine and N-Halo Compounds in Transformations of Organic Molecules*: doctoral dissertation, Ljubljana, 2013 (mentor Marjan Jereb; co-mentor Stojan Stavber).

ELECTRONIC CERAMICS DEPARTMENT

K-5

The Electronic Ceramics Department is active in the research of the synthesis, properties and applications of materials for electronics and energetics, mainly complex multifunctional materials and structures. The materials of interest include ceramic piezoelectrics, ferroelectrics, relaxors, multiferroics and conductive oxides. The emphasis is on creating the properties by the synthesis and structure on the nano-, micro- and macro-levels. The group also works on the principles of the basic technologies of ceramic pressure sensors, ceramic MEMS and flexible electronics.



Head:
Prof. Barbara Malič

In the framework of lead-free piezoelectric materials we were particularly interested in alkali-niobate-based ceramics, which are still considered as one of the most important candidates for the replacement of lead-based perovskites in piezoelectric applications. In collaboration with Keio University from Japan we developed a new synthesis method for the preparation of fine and single-phase potassium sodium niobate ($K_{0.5}Na_{0.5}NbO_3$) powders. The method consists of the attrition milling of fine Nb_2O_5 particles suspended in an ethanol solution of sodium and potassium acetates. We obtained a single-phase KNN powder by calcining the milled powder twice at temperatures as low as 450-650°C, which are 100-200°C lower than those typically used during the conventional solid-state synthesis of KNN.

Using optical dilatometry and a detailed microstructural analysis we studied the sintering behaviour of sodium niobate ($NaNbO_3$) powders with particles of nanometre and submicrometre sizes. We found that the initial particle size did not affect the evolution of the microstructure upon annealing, suggesting a key role of the mechanisms responsible for the grain growth in the initial stage of the sintering. By measuring the specific surface area of the specimens, which were annealed at different temperatures, we found that the observed grain growth is due to the surface diffusion. Owing to the low activation energy (50-60 kJ/mol), in fact, this grain-growth mechanism is activated in the initial stage of the sintering and, thus, decreases the driving force for the sintering and prevents any further densification of the powder compact. $NaNbO_3$ ceramics with a relative density of 98% and an average grain size of $0.7 \pm 0.29 \mu m$ were successfully prepared by hot pressing at 1150°C. The results significantly contribute to the general understanding of the sintering of alkali-niobate-based ceramics and suggest ways to control the microstructure of this important group of lead-free piezoceramics.

Within the activities on lead-based piezoelectric ceramics, we focused on the solid-state synthesis and characterization of the $Pb(Zr,Ti)O_3$ (PZT) ceramics, mechanically toughened by tetragonal-stabilized zirconia (TZ) particles. In order to achieve a homogeneous distribution of TZ grains within the PZT matrix, we developed a modified solid-state synthesis procedure, consisting of pre-milling, pH adjustment and a modification of the surface of the TZ powder. According to the Voronoi-diagram analysis of the microstructures of the ceramics, the modified synthesis route provided a more homogeneous TZ distribution in the PZT matrix, as compared to the composites processed by conventional means (figure 1). The R-curve measurements, performed at the Technische Universität Darmstadt, however, did not show a measureable difference in the fracture behaviour of the two PZT-TZ composites.

Within the 7FP EU project CERAMPOL and in collaboration with the company HIPOT-RR we continued our work on the integration of piezoelectric PZT actuators in waste-water cleaning systems. Based on the vibration measurements of a corundum substrate with integrated piezoelectric actuators, we were able to evaluate the influence of various parameters, such as the type of the piezoelectric material and the position of the actuators, on the amplitude and frequency of the substrate vibration resonances. A numerical analysis of the different substrate/actuator structures showed trends in the vibration behaviour. A combination of the numerical analysis and the experimental verification made it possible to identify the main parameters of the vibration system, like those mentioned above, which will be further optimized within the project.

As a co-author, Tadej Rojac published a review article on mechanochemical synthesis entitled "Hallmarks of mechanochemistry: from nanoparticles to technology" in the high-impact journal *Chemical Society reviews*, 2013, 42, 7571 (impact factor for 2012: 24.89).

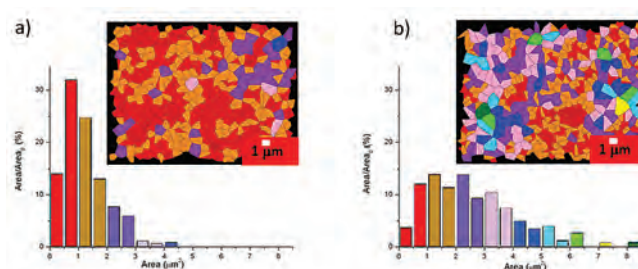


Figure 1: The area size distribution of the Voronoi polygons of PZT/TZ composites prepared by modified (a) and non-modified (b) synthesis methods. The insets show the Voronoi diagrams.

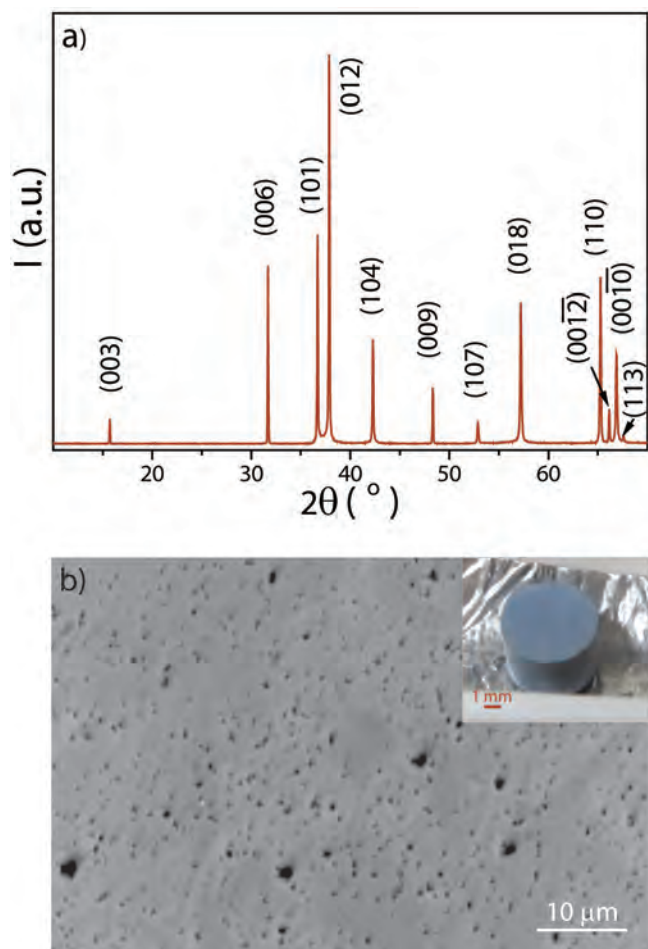


Figure 2: X-ray diffraction pattern (a) and microstructure (b) of CuAlO_2 ceramics, sintered at 1100°C for 2 hours in air. The inset shows a photo of the ceramic sample.

In collaboration with the Department for Condensed Matter Physics we studied the **electrocaloric (EC) response** of $0.7\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3-0.3\text{PbTiO}_3$ bulk ceramics, processed from mechanochemically activated powders. The highest temperature change of 2.7 K was observed in the vicinity of the critical point, i.e., at 430 K, and under an applied electric field of 90 kV/cm. In addition, we investigated the EC response of the environmentally friendly lead-free relaxor $\text{K}_{0.5}\text{Na}_{0.5}\text{NbO}_3\text{-SrTiO}_3$ (KNN-STO) ceramics. The results confirmed the large EC response in the vicinity of the dielectric anomaly. The EC temperature change at room temperature is comparable to that measured in lead-based ceramics.

Using the inkjet printing of water-based dispersions of submicron lead zirconate titanate (PZT) particles we prepared films with thicknesses of a few micrometres. We confirmed the local piezoelectric response of such PZT films by means of piezo-response force microscopy.

The $0.57\text{Pb}(\text{Sc}_{1/2}\text{Nb}_{1/2})\text{O}_3-0.43\text{PbTiO}_3$ (PSN-PT) is a perovskite material that can be used in various piezoelectric applications, including sensors, actuators and ultrasound transducers. The integration of such functional materials onto substrates in the form of thin or thick films often results in thermal stresses in the film, which have their origin in the mismatch between the thermal expansion coefficient of the active layer and the substrate, and may significantly affect the functional response of the material. In order to understand and control these stresses, the linear expansion coefficient of the PSN-PT must be known, in both the unpoled and poled states. We found that the thermal expansion coefficient of PSN-PT increases from 30°C up to the Curie temperature of 260°C , where it reaches $2.08 \cdot 10^{-6} \text{K}^{-1}$. The phase transition was identified as an anomaly in the expansion between 260°C and 280°C . The coefficient of thermal expansion then increases with a further increase in the temperature, reaching $9.66 \cdot 10^{-6} \text{K}^{-1}$ at 400°C . These data will be essential for the integration of PSN-PT in thin- or thick-film structures.

In collaboration with the Ecole Polytechnique Fédérale de Lausanne, Switzerland, we studied the **elastic properties** of $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ (PMN) ceramics. It was shown that the PMN ceramics exhibit true anelastic relaxor behavior with the parameters of the Vogel-Fulcher equation similar to those for dielectric relaxation.

We continued our research on **multiferroic BiFeO_3** ceramics, focusing on the $(\text{Bi,RE})\text{FeO}_3$ (RE=Sm, Gd, Dy) compositions, which exhibit morphotropic phase boundaries. By combining the milling of the starting powders in ethanol with the addition of polyacrylic acid and subsequent mechanochemical activation, we succeeded in preparing homogeneous powders with the sintering temperatures as low as 800°C . The powders were then used to prepare homogeneous and dense bulk ceramics. Like in the case of BiFeO_3 , the ceramics modified by the RE oxides exhibited large electric-field induced strains, which exceeded 0.3%. The advantage of these modified ceramics over the unmodified BiFeO_3 is that the strain shows little dependence on the driving electric-field frequency; as compared to unmodified BiFeO_3 , the response of RE-modified ceramics is thus more stable.

In the framework of **lead-free ferroelectric thin films** prepared by Chemical Solution Deposition, we collaborated with the Ecole Centrale Paris, France, and investigated the phase transitions of KNN thin films deposited onto $(111)\text{Pt}/\text{TiO}_2/\text{SiO}_2/\text{Si}$ substrates. The purpose was to compare the phase-transition behaviour of the KNN films with two different microstructures, i.e., columnar and granular. Raman spectroscopy and X-ray diffraction analysis confirmed the presence of both phase transitions as observed in the KNN powder, i.e., the monoclinic-to-tetragonal ($T_{\text{M-T}}$) and the tetragonal-to-cubic ($T_{\text{T-C}}$). Whereas the $T_{\text{M-T}}$ transition of the film with the columnar microstructure was similar to that observed in the KNN powder, the Curie temperature ($T_{\text{T-C}}$) was slightly lower. We attribute this lowering of the T_{C} to the presence of tensile stresses, which develop as a consequence of the thermal expansion coefficient mismatch between the film and the substrate.

Within the project FERROPATCH in the frame of the program JP PECS of the European Space Agency (ESA) we prepared $\text{Ba}_{0.5}\text{Sr}_{0.5}\text{TiO}_3$ (BST) thin-film varactors on alumina substrates. Single-phase and dense films with homogenous microstructures and thicknesses between 70 nm and 600 nm were prepared by annealing the as-deposited films at temperatures up to 900°C . The highest dielectric permittivity was measured in the 170-nm-thick sample and was 1310 at 100 kHz and 1210 at 10 GHz. In addition, we also studied the synthesis of BST nanoparticles,

which were prepared via the thermal degradation of acetylacetonate precursors in oleylamine under the presence of stearic acid, used as surfactant. The particles were amorphous and crystallized into the perovskite phase after annealing at 700 °C.

The work within the 7FP EU ORAMA project was concentrated on the synthesis of oxide semiconductors and dielectrics for **transparent electronics**. CuAlO_2 , which is a p-type semiconductor, was synthesized by annealing a stoichiometric mixture of nano-boehmite (AlOOH) and Cu_2O at 1100 °C in an argon atmosphere. In contrast to the conventional synthesis from a mixture of oxide powders, this synthesis method represents an efficient way toward the phase-pure delafossite. By sintering the as-prepared powder compacts at 1100 °C for 2 hours in air, we succeeded in preparing X-ray-diffraction phase-pure ceramics with 86% of relative density, which can be used as sputtering targets (figure 2).

Our studies related to thin dielectric films with a high permittivity for transparent electronic components were focused on thin films based on Ta_2O_5 and $\text{Ta}_2\text{O}_5\text{-Al}_2\text{O}_3\text{-SiO}_2$, which were prepared by Chemical Solution Deposition. The films, deposited onto glass substrates and processed at temperatures up to 400 °C, showed an optical transmittance of ~80 %, a dielectric permittivity of ~20 and a low leakage current. These films are thus suitable for use in thin-film capacitors or transistors. In addition, we adopted inkjet printing for the deposition of thin films of n-type conducting oxides based on ZnO and SnO_2 onto various substrates.

Within the research on the processing of **piezoelectric thick films** by the **electrophoretic deposition (EPD) process**, we systematically studied the influence of the polyacrylic acid / organic base ratio on the electrical conductivity of the dispersion and on the thickness uniformity of the as-deposited layers. At the optimal polyacrylic acid / organic base ratio we obtained a stable dispersion of donor-doped PZT particles in ethanol with a low electrical conductivity. The deposited layer had a thickness of 30 μm and was uniform and homogeneous. The dispersions were used for the processing of thick films on curved porous PZT substrates. In the next step and in collaboration with researchers from François-Rabelais University from Tours, France, we fabricated geometrically-focused high-frequency ultrasound transducers (US) for medical diagnoses. With the colleagues from Tours we also investigated the functional properties of $0.65\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3\text{-}0.35\text{PbTiO}_3$ (PMN-PT) thick films for US transducers. The results suggest that the PMN-PT thick-film transducers are superior to those made from the standard $\text{Pb}(\text{Zr,Ti})\text{O}_3$ (PZT) piezoelectric material.

We studied the preparation of **PZT ceramics with a controlled amount, size and distribution of pores**, which could be used as substrates for high-frequency ultrasound transducers. The method consists of the hetero-coagulation of PZT and polymethyl methacrylate (PMMA) particles.

We developed a procedure for the processing of aqueous dispersions of ceramic particles, suitable for the patterning of thick films by piezoelectric inkjet printing. We reduced the average particle size of a micron-sized PZT powder to a few tens of nanometres by milling and provided an effective dispersion of PZT particles in water by controlling the pH of the dispersion, and the type and amount of dispersant. The ink with an optimized average PZT particle size, surface tension and viscosity was inkjet printed onto platinised corundum substrates. The inkjet printed structures, dried and fired at 1100 °C, were dense and ~5 μm thick. The local piezoelectric response of the PZT film was confirmed using an atomic force microscope equipped with a piezoresponse-force module (figure 3).

By optimizing the rheological properties of the ink we improved the procedure for the processing of **KNN thick films using screen-printing technology**. The films were deposited onto substrates with different thermal expansion coefficients, so that different degrees of in-plane biaxial stresses were induced in the films. The influence of these stresses was reflected in the structural and functional properties of the films. The most important is the phenomenon of 'self-poling' of the KNN thick films, the extent of which depended on the mechanical stresses, i.e., on the type of the substrate.

We continued the investigations on **LTCC (Low Temperature Co-fired Ceramics)**, used for the fabrication of 3D structures for different electromechanical (MEMS - Micro Electro Mechanical Systems) and chemical microsystems. In collaboration with the partners from Montanuniversität Leoben, Austria, we studied the influence of the firing conditions on the microstructure and mechanical properties of Du Pont LTCC. We concluded that the porosity has a major influence on the elastic modulus, the fracture toughness, the hardness and the biaxial flexural strength

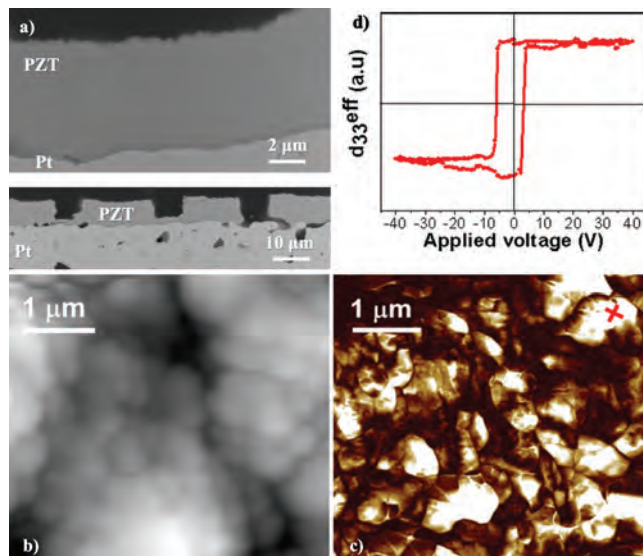


Figure 3: PZT thick film on the Pt/Al₂O₃ substrate prepared by inkjet printing. a) scanning electron microscopy (SEM) image of the cross-section b) atomic-force microscopy (AFM) image and c) out-of-plane amplitude PFM image of the surface of the PZT thick film; d) local $d_{33}(V)$ hysteresis loop obtained from a selected area on the film.

We fabricated a ceramic micro reactor with large cavities for the catalytical production of hydrogen from methanol and water by using LTCC technology.

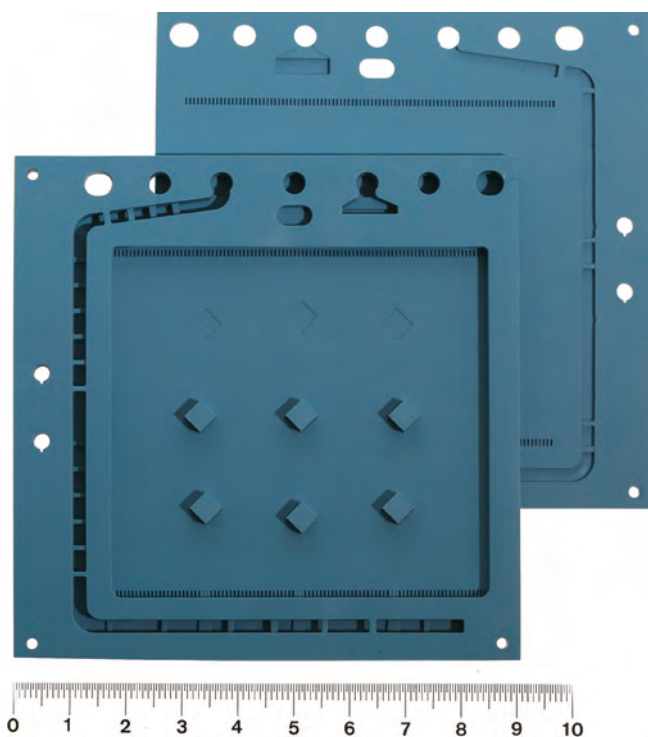


Figure 4: LTCC reactor for high-temperature catalytic production of hydrogen from methanol and water. The external dimensions of the structure are 90 mm × 90 mm × 9.2 mm and the volume of the buried cavities is 18.7 cm³. The figure shows the bottom part of the reactor with nine supports.

catalytic transformation of methanol and water into hydrogen. It is worth mentioning that we succeeded in designing and constructing two reactors, i.e., one for the steam reforming and the other for the removal of the residual carbon monoxide from gas products. Both reactors had large buried cavities where the chemical reactions take place; the volume of the reformer and the reactor for CO removal was 18.7 cm³ and 5.4 cm³, respectively. These, rather extreme dimensions for LTCC technology, were fabricated in order to satisfy the required production of 85 litres of hydrogen per hour. The realisation of these **particularly large cavities** required special LTCC lamination procedures and a controlled firing process. The final dimensions of the reformer and the reactor for CO-removal were, respectively, 90 mm × 90 mm × 9.2 mm and 90 mm × 36 mm × 9.2 mm (figure 4).

In collaboration with the company ETI d.d. Izlake we investigated various silicate materials, i.e., steatite and cordierite, which are used in electrical engineering as heat or electrical insulators. We systematically studied the influence of raw materials on the microstructure, mechanical and electrical properties of the ceramics. At the optimal amount of selected raw materials and at the optimal milling conditions we prepared a new type of dense, alkaline steatite with a high flexural strength (~185 MPa) and a high specific electrical resistivity (~0.8 MΩ m). The resulting material was prepared on a production scale in the company and is now used for the fabrication of electrical fuses.

Some outstanding publications in the past year

1. Baláž, P., Rojac, T., et al.: Hallmarks of mechanochemistry: from nanoparticles to technology. *Chemical Society reviews*, vol. 42, 7571–7637, 2013, doi: 10.1039/C3CS35468G [COBISS.SI-ID 26654759]
2. Hreščak, J., Benčan, A., Rojac, T., Malič, B.: The influence of different niobium pentoxide precursors on the solid-state synthesis of potassium sodium niobate, *J. Eur. Ceram. Soc.*, vol. 33, 3065–3075, 2013, doi: 10.1016/j.jeurceramsoc.2013.07.006
3. Vojsavljevič, K., Malič, B., Mamoru, S., Drnovšek, S., Kosec, M.: Solid state synthesis of nano-boehmite-derived CuAlO₂ powder and processing of the ceramics, *J. Eur. Ceram. Soc.*, vol. 33, 3231–3241, 2013, doi: 10.1016/j.jeurceramsoc.2013.05.025
4. Kušcer, D., Noshchenko, O., Uršič, H., Malič, B.: Piezoelectric properties of ink-jet printed lead zirconate titanate thick films confirmed by piezoresponse force microscopy, *J. Am. Ceram. Soc.*, vol. 96, 2714–2717, 2013, doi: 10.1111/jace.12532

of the LTCC. If the LTCC materials are fired at elevated temperatures for prolonged periods, so that the porosity is reduced, their properties remained unchanged, regardless of the firing temperature and/or firing time. This finding is important for the design and production of ceramic pressure sensors and other MEMS devices, which require relatively long firing procedures at higher temperatures, as compared to the conditions usually required for the processing of LTCC. In 2013 we reinforced the collaboration with KEKO Oprema d.o.o. in the field of materials and technologies based on LTCC.

Traditional co-operation with the research partners from HIPOT-RR and Centre of Excellence NAMASTE continued in all the research projects related to thick-film and LTCC technology. With the group from the company KEKON d.o.o. we continued our research in the field of functional thick-film materials, in particular, we investigated **new thick-film lead-free resistors** as possible sensor elements. We found that the temperature dependence of resistivity of these materials satisfies the needs for the application, however, the “gauge” factors, i.e., the dependence of the resistivity on the deformation, are three times lower than required, so that these materials are not suitable as pressure sensors. We also tested a commercial ESL 3411-I thick-film resistor with a **high and linear dependence of resistivity versus temperature** and a low sheet resistivity. The results suggested that this material is compatible with LTCC tapes and that it could be used for temperature measurements over large surfaces. This material was successfully used as a sensor for temperature control and regulation in large LTCC chemical reactors.

Within the programme JE PECS of the European Space Agency (ESA), we continued our work on the CERACON project, together with the partners from the Department of Systems and Control, and the National Institute of Chemistry. The topic of the project was the **design and fabrication of LTCC-based micro reactors** and the necessary periphery for the high-temperature

5. Kupec, A., Gemeiner, P., Dkhil, B., Malič, B.: Phase transitional behavior of potassium sodium niobate thin films, *Thin solid films*, vol. 539, 317–322, 2013, doi: 10.1016/j.tsf.2013.05.098

Organization of conferences, congresses and meetings

1. COST Training school on characterization of materials, Ljubljana, Slovenia, 28.–29. 1. 2013

Patent granted

1. Luca Gregoratti, Marco Peloi, Marija Kosec, Danjela Kuščer, Giuseppina Palma, A material in the form of lithium fluoride powder containing colour centres, method for preparation and use thereof, US8535434 (B2), US Patent Office, 17.9.2013.
2. Kostja Makarovič, Janez Holc, Darko Belavič, Marko Hrovat, Marija Kosec, Multilayer ceramic structures for non-contact dielectric heating of liquids, SI24008 (A), Urad RS za intelektualno lastnino, 30.8.2013.
3. Marina Santo-Zarnik, Darko Belavič, Marjan Hodnik, Sandi Kocjan, A pressure-sensor module with a ceramic cantilever sensing structure, SI24085 (A), Urad RS za intelektualno lastnino, 29.11.2013.

INTERNATIONAL PROJECTS

1. 7FP - ORAMA; Oxide Materials Towards a Matured Post-silicon Electronics Era
European Commission
Prof. Barbara Malič
2. 7FP - CERAMPOL; Ceramic and Polymeric Membrane for Water Purification of Heavy Metal and Hazardous Organic Compound
European Commission
Asst. Prof. Danjela Kuščer Hrovatin
3. 7FP - PI; The Piezo Institute - European Expertise Centre for Multifunctional and Integrated Piezoelectric Devices
European Commission
Prof. Barbara Malič
4. CERACON; Integration and Control of Liquid Fuel processor based on Ceramic Micro-Systems
ESA/ESTEC
Asst. Prof. Marko Hrovat
5. COST MP0904; SIMUFER: Single- and Multiphase Ferroics and Multiferroics with Restricted Geometries
COST Office
Prof. Barbara Malič
6. FERRO-PATCH; Frequency and Polarisation Agile Microstrip Patch Antenna based on Ferrelectric Varactors
ESA/ESTEC
Prof. Barbara Malič
7. Solution Processing of Thin Films for Transparent Electronics (TRANS)
Slovenian Research Agency
Prof. Barbara Malič
8. Dielectric Spectroscopy and Tunability of Low-Temperature Recessed Complex Perovskites
Slovenian Research Agency
Prof. Barbara Malič

R&D GRANTS AND CONTRACTS

1. Nanostructures for High-Efficiency Solar Cells and Photovoltaic
Prof. Barbara Malič
2. Oxide-Based Components for Transparent Electronics
Prof. Barbara Malič
3. Tunable Ferroelectric Thin Film Capacitors for Agile Microwave Antennas
Prof. Barbara Malič
4. High-performance Piezoelectric Materials for Sensors and Actuators in High-temperature Applications
Asst. Prof. Tadej Rojac
5. Textured Ceramic Films for Sensors and Actuators
Asst. Prof. Tadej Rojac
6. Materials and Technologies for Chemical Microsystems
Asst. Prof. Andreja Benčan Golob
7. Pb(Sc_{0.5}Nb_{0.5})O₃-PbTiO₃ Thick Films for Sensor and Actuator Applications
Dr. Hana Uršič Nemevšek

NEW CONTRACTS

1. Evolution of Microstructure in Non-porous Bulk Ceramics with Selected Properties for Applications in Low Temperature Cofired Ceramic (LTCC) structures
Keko - Oprema, d. o. o., Žužemberk
Prof. Barbara Malič
2. Materials and Technologies for Chemical Microsystems
Keko - Oprema, d. o. o., Žužemberk
Asst. Prof. Andreja Benčan Golob
3. Nanomaterials in Ceramics-Feasibility Study
RC eNeM
Prof. Barbara Malič

RESEARCH PROGRAM

1. Electronic Ceramics, Nano-, 2D and 3D Structures
Prof. Barbara Malič

VISITORS FROM ABROAD

1. Julian Walker, School of Materials Science & Engineering, University of New South Wales, Sydney, Australia, 1. 1.–31. 7. 2013
2. Prof. Liliana Mitoseriu, University "Al. I. Cuza", Faculty of Physics, Iasi, Romania, 23.–30. 1. 2013
3. Dr. Denis Schütz, CD-Lab for Advanced Ferroic Materials, Graz, Austria, 27. 1.–14. 4. 2013
4. Dr. Nadejda Horchidan, University "Al. I. Cuza", Faculty of Physics, Iasi, Romania, 27. 1.–22. 2. 2013
5. Andre-Pierre Abellard, Université François Rabelais, Tours, France, 2.–29. 3. 2013
6. Pierrick Chevreux, Ecole Nationale Supérieure Céramique Industrielle, Limoges, France, 3. 3.–7. 6. 2013
7. Prof. Dragan Damjanovic, Swiss Federal Institute of Technology-EPFL, Lausanne, Switzerland, 6.–9. 3. 2013
8. Dr. Marco Deluca, Institut für Struktur- und Funktionskeramik, Montanuniversität Leoben, Materials Center Leoben Forschung GmbH, Leoben, Austria, 15. 3. 2013
9. Naima Benyagoub, Magali Leger, Prof. Marc Lethiecq, Prof. Franck Levassort, Université François Rabelais, Tours, France, 24.–29. 3. 2013
10. Dr. Marko Budimir, Institute for Nuclear Technology-INETEC, Zagreb, Croatia, 13. 5. 2013
11. Prof. Jürgen Rödel, Technische Universität Darmstadt, Darmstadt, Germany, 16.–17. 5. 2013
12. Prof. Klaus Reichmann, Graz University of Technology, Graz, Austria, 17. 5. 2013
13. Prof. Angus I. Kingon, Brown University, Rhode Island, USA, 9.–17. 6. 2013

14. Goran Mišković, Vienna University of Technology, Institute of Sensor and Actuator Systems, Vienna, Austria, 13. 6. 2013
15. Dr. Vassilios Binas, Foundation for Research & Technology Hellas (FORTH), Institute for Electronic Structure and Laser (IESL), Crete, Greece, 8.-25. 9. 2013
16. Dr. Gregor Trefalt, University of Geneva, Geneva, Switzerland, 9.-13. 9. 2013
17. Prof. Raul Bermejo, Institut für Struktur-und Funktionskeramik, Montanuniversität Leoben, Leoben, Austria, 22.-23. 9. 2013
18. Prof. Mariuca Gartner, Prof. dr. Maria Zaharescu, "Ilie Murgulescu" Institute of Physical Chemistry of Romanian Academy, Bucharest, Romania, 4.-8. 11. 2013

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1. Asst. Prof. Andreja Benčan Golob
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17. Evgeniya Khomyakova, B. Sc.

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Note:

* part-time JSI member

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Ilze Aulika, Silvana Mergan, Andreja Benčan, Q. Zhang, Alexandr Dejneka, Marija Kosec, K. Kundzins, D. Demarchi, P. Civera, "Impact of crystallisation processes on depth profile formation in solgel $\text{PbZr}_{0.52}\text{Ti}_{0.48}\text{O}_3$ thin films", *Advances in applied ceramics*, vol. 112, issue 1, pp. 55-58, 2013.
2. Darko Belavič, Marko Hrovat, Gregor Dolanc, Kostja Makarovič, Marina Santo-Zarnik, "Design and fabrication of an LTCC structure for a microceramic combustor: invited paper", *J. microelectron. electron. packag.*, vol. 9, no. 3, pp. 120-125, 2013.
3. N. Bensemmal, Gregor Trefalt, Sebastjan Glinšek, Marija Kosec, K. Taibi, M. Abbaci, "Investigation of the $\text{BaTiO}_3\text{BaMg}_{1/3}\text{Nb}_{2/3}\text{O}_3$ system structural, dielectric, ferroelectric and electromechanical studies", *Journal of electroceramics*, vol. 30, no. 4, pp. 206-212, 2013.
4. Vid Bobnar, Hana Uršič, Goran Casar, Silvo Drnovšek, "Distinctive contributions to dielectric response of relaxor ferroelectric lead scandium niobate ceramic system", *Phys. status solidi, b Basic res.*, vol. 250, no. 10, pp. 2232-2236, 2013.
5. Goran Casar, Xinyu Li, Jurij Koruza, Qiming M. Zhang, Vid Bobnar, "Electrical and thermal properties of vinylidene fluoride-trifluoroethylene-based polymer system with coexisting ferroelectric and relaxor states", *J. Mater. Sci.*, vol. 48, no. 22, pp. 7920-7926, 2013.
6. Jovana Čirković, Katarina Vojisavljevič, Maja Ščepanovič, Aleksander Rečnik, Goran Branković, Zorica Branković, Tatjana Srečković, "Hydrothermally assisted complex polymerization method for barium strontium titanate powder synthesis", *J. sol-gel sci. technol.*, vol. 65, issue 2, pp. 121-129, 2013.
7. Jitka Hreščak, Andreja Benčan, Tadej Rojac, Barbara Malič, "The influence of different niobium pentoxide precursors on the solid-state synthesis of potassium sodium niobate", *J. Eur. Ceram. Soc.*, vol. 33, issue 15-16, pp. 3065-3075, 2013.
8. Alja Kupec, Pascale Gemeiner, Brahim Dkhil, Barbara Malič, "Phase transitional behavior of potassium sodium niobate thin films", *Thin solid films*, vol. 539, pp.317-322, 2013.
9. Danjela Kuščer, Tina Bakarič, Bojan Kozlevčar, Marija Kosec, "Interactions between lead-zirconate titanate, polyacrylic acid, and polyvinyl butyral in ethanol and their influence on electrophoretic deposition behavior", In: Proceedings of the 4th International Conference on Electrophoretic Deposition: Fundamentals and Applications, October 2-7, 2011, Puerto Vallarta, Mexico, *J. Phys. Chem. B*, vol. 117, no. 6, pp. 1651-1659, 2013.
10. Danjela Kuščer, Oleksandr Noshchenko, Hana Uršič, Barbara Malič, "Piezoelectric properties of ink-jetprinted lead zirconate titanate thick films confirmed by piezoresponse force microscopy", *J. Am. Ceram. Soc.*, vol. 96, no. 9, pp. 2714-2717, 2013.
11. Kostja Makarovič, Andreja Benčan, Marko Hrovat, Janez Holc, Barbara Malič, Marija Kosec, Raúl Bermejo, Irina Kraveva, "The effect of phase composition on the mechanical properties of LTCC material", *International journal of applied ceramic technology*, vol. 10, issue 3, pp. 449-457, 2013.
12. Kostja Makarovič, Anton Meden, Marko Hrovat, Darko Belavič, Janez Holc, Marija Kosec, "Non-destructive quantitative phase analysis of an LTCC material", *Microelectron. int.*, vol. 30, no. 2, pp. 73-76, 2013.
13. Matejka Podlogar, Damjan Vengust, Jacob J. Richardson, Martin Strojnik, Matjaž Mazaj, Gregor Trefalt, Nina Daneu, Aleksander Rečnik, Slavko Bernik, "Parametric study of seed-layer formation for low-temperature hydrothermal growth of highly oriented ZnO films on glass substrates", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, issue 6, pp. 1083-1092, 2013.
14. Jürgen Rödel, Yo-Han Seo, Andreja Benčan, Barbara Malič, Marija Kosec, Kyle Webber, "R-curves in transformation toughened lead zirconate titanate", *Eng. fract. mech.*, vol. 100, pp. 86-91, 2013.
15. Brigita Rožič, Marko Jagodič, Sašo Gyergyek, Zvonko Jagličič, Samo Kralj, Vassilios Tzitzios, George Cordoyiannis, Zdravko Kutnjak, "Indirect magnetoelectric coupling in mixtures of magnetite and ferroelectric liquid crystal", In: Proceedings of the ISAF ECAPD PMF 2012, International Symposium on Applications of Ferroelectrics; European Conference on the Applications of Polar Dielectrics; International Symposium Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials, 9-13 of July, 2012, Aveiro, Portugal, *Ferroelectrics*, vol. 448, no. 1, pp. 12-16, 2013.
16. Brigita Rožič, Jurij Koruza, Zdravko Kutnjak, George Cordoyiannis, Barbara Malič, Marija Kosec, "The electrocaloric effect in lead-free $\text{K}_{0.5}\text{Na}_{0.5}\text{NbO}_3 - \text{SrTiO}_3$ ceramics", In: Proceedings of the ISAF ECAPD PMF 2012, International Symposium on Applications of Ferroelectrics; European Conference on the Applications of Polar Dielectrics;

- International Symposium Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials, 9-13 of July, 2012, Aveiro, Portugal, *Ferroelectrics*, vol. 446, no. 1, pp. 39-35, 2013.
- Marina Santo-Zarnik, Darko Belavič, Vlasta Sedlakova, Josef Sikula, Martin Kopecky, Petr Sedlak, Jiri Majzner, "Comparison of the intrinsic characteristics of LTCC and silicon pressure sensors by means of 1/f noise measurements", *Radioengineering (Prague)*, vol. 22, no. 1, pp. 227-232, 2013.
 - Marina Santo-Zarnik, Vlasta Sedlakova, Darko Belavič, Josef Sikula, Jiri Majzner, Petr Sedlak, "Estimation of the long-term stability of piezoresistive LTCC pressure sensors by means of low-frequency noise measurements", *Sens. actuators, A, Phys.*, vol. 199, pp. 334-343, 2013.
 - Yo-Han Seo, Daniel J. Franzbach, Jurij Koruza, Andreja Benčan, Barbara Malič, Marija Kosec, Jacob L. Jones, Kyle Webber, "Nonlinear stress-strain behavior and stress-induced phase transitions in soft $\text{Pb}(\text{Zr}_{1-x}\text{Ti}_x)\text{O}_3$ at the morphotropic phase boundary", *Phys. rev. B, Condens. matter mater. phys.*, vol. 87, no. 9, pp. 094116-1-094116-11, 2013.
 - Hana Uršič, Dragan Damjanović, "Anelastic relaxor behavior of $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ ", *Appl. phys. lett.*, vol. 103, no. 7, pp. 072904-1-072904-4, 2013.
 - Hana Uršič, Janez Holc, Marija Kosec, "Influence of the sintering conditions on the properties of 0.57PSN0.43PT ceramics prepared from mechanochemically activated powder", *J. Eur. Ceram. Soc.*, vol. 33, no. 4, pp. 795-803, 2013.
 - Hana Uršič, Franck Levassort, Janez Holc, Marc Lethiecq, Marija Kosec, "0.65Pb(Mg₁₋₃Nb₂₋₃)O₃0.35PbTiO₃ thick films for high-frequency piezoelectric transducer applications", *Jpn. j. appl. phys.*, vol. 52, no. 5, pp. 055502-1-055502-6, 2013.
 - Hana Uršič, Barbara Malič, Jena Cilenšek, Tadej Rojac, Brigita Kmet, Marija Kosec, "Linear thermal expansion coefficients of relaxor-ferroelectric 0.57Pb(Sc_{1/2}Nb_{1/2})O₃ - 0.43PbTiO₃ ceramics in a wide temperature range", *J. Eur. Ceram. Soc.*, vol. 33, no. 11, pp. 2167-2171, 2013.
 - Mirjana M. Vijatović Petrović, Jelena D. Bobić, Hana Uršič, J. Banys, Biljana Stojanović, "The electrical properties of chemically obtained barium titanate improved by attrition milling", *J. sol-gel sci. technol.*, vol. 67, no. 2, pp. 267-272, 2013.
 - Katarina Vojisavljević, Barbara Malič, Senna Mamoru, Silvo Drnovšek, Marija Kosec, "Solid state synthesis of nano-boehmite-derived CuAlO₂ powder and processing of the ceramics", *J. Eur. Ceram. Soc.*, vol. 33, no. 15/16, pp. 3231-3241, 2013.
 - kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, 7 pp.
 - Darko Belavič, Marko Hrovat, Kostja Makarovič, Vlasta Sedlakova, Josef Sikula, Marina Santo-Zarnik, "Investigations of thick K-film piezoresistors terminated with silver-based thick-film conductors", In: *Proceedings*, EDS'13, Electronic Devices and Systems IMAPS CS International Conference 2012, June 26-27, 2013, Brno, Czech Republic, Ondrej Hegr, ed., Brno, Vysoké učení Technické v Brně, 2013, pp. 218-223.
 - Barbara Bertoncelj, Katarina Vojisavljević, Janez Rihtaršič, Gregor Jelenc, Barbara Malič, Marko Stušek, Darko Belavič, "Characterization of glass fiber reinforced composites for housing of electrical motors", In: *Proceedings*, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 101-106.
 - Goran Casar, Jurij Koruza, Vid Bobnar, Xinyu Li, Qiming M. Zhang, "Nonlinear dielectric response of polymer system with coexisting ferroelectric and relaxor states", In: *2013 Joint UFFC, EFTF and PFM Symposium*, International Ultrasonics Symposium (IUS), Joint IEEE International Symposium on the Applications of Ferroelectrics (ISAF) and Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials (PMF), Joint International Frequency Control Symposium (IFCS), and European Frequency and Time Forum (EFTF), 21-25 July 2013, Prague, Czech Republic IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society International Ultrasonics Symposium (IUS), Joint IEEE International Symposium on the Applications of Ferroelectrics (ISAF) and Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials (PMF), Joint International Frequency Control Symposium (IFCS), and European Frequency and Time Forum (EFTF), 21-25 July 2013, Prague, Czech Republic, [S. l.], IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society, 2013, pp. 159-161.
 - Goran Casar, Xinyu Li, Jurij Koruza, Qiming M. Zhang, Vid Bobnar, "Electrical and thermal properties of polymer systems with coexisting ferroelectric and relaxor states", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 250-256.
 - Gregor Dolanc, Marko Hrovat, Primož Fajdiga, Stanko Hočvar, Andrej Pohar, Kostja Makarovič, Darko Belavič, "System with ceramic LTCC micro-reactor for steam reforming", In: *Proceedings*, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 251-256.
 - Raluca C. Frunza, Brigita Kmet, Karsten Rachut, Marko Jankovec, Marko Topič, Andreas Klein, Barbara Malič, "Solution-derived Ta₂O₅-based dielectric thin films for transparent electronic devices", In: *Proceedings*, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 239-244.
 - Raluca C. Frunza, Martin Strojnik, Marko Jankovec, Marko Topič, Barbara Malič, "Investigation of the structural, optical and electrical properties of Ta₂O₅-rich thin films from solution", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 268-277.
 - Marko Hrovat, Darko Belavič, Kostja Makarovič, "'Green' thick film resistors on various substrates", In: *Proceedings*, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 257-261.
 - Marko Hrovat, Darko Belavič, Kostja Makarovič, "Lead-free thick-film resistors on slumina and LTCC substrates", In: *Extended abstracts*, ISSE 2013, 36th International Spring Seminar on Electronics Technology,

REVIEW ARTICLE

- Peter Baláž *et al.* (16 authors), "Hallmarks of mechanochemistry: from nanoparticles to technology", *Chem. Soc. rev.*, vol. 42, issue 18, pp. 7571-7637, 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

- Danjela Kuščer, Andre-Pierre Abellard, Marija Kosec, Franck Levassort, "Piezoelectric thick-film structures for high-frequency transducer applications prepared by electrophoretic deposition", In: *Processing and properties of advanced ceramics and composites V*, (Ceramic transactions, vol. 240), Narottam P. Bansal, ed., [S. l.], Wiley, 2013, pp. 131-141.
- Marina Santo-Zarnik, Milenko Pavlović, Darko Belavič, Vlasta Sedlakova, Josef Sikula, Jiri Majzner, "Effect of media on the warm-up and the offset characteristic of piezoresistive ceramic pressure sensors", In: *Proceedings*, EDS'13, Electronic Devices and Systems IMAPS CS International Conference 2012, June 26-27, 2013, Brno, Czech Republic, Ondrej Hegr, ed., Brno, Vysoké učení Technické v Brně, 2013, pp. XXI-XXVI.

PUBLISHED CONFERENCE CONTRIBUTION

- Andre-Pierre Abellard, Franck Levassort, Jean Marc Grégoire, Marc Lethiecq, Danjela Kuščer, Janez Holc, "PZT thick films obtained by electrophoretic deposition (EPD) process for high frequency focused transducers", In: *IUS 2012*, 2012 IEEE International Ultrasonic Symposium, October 7-10, 2012, Dresden, German, [S. l.], IEEE, 4 pp..
- Tina Bakarič, Danjela Kuščer, Barbara Malič, "Keramika svinčevega cirkonata titanata z določeno obliko in velikostjo por", In: *Slovenski*

- "Automotive electronics", Alba, Iulia, Români, Emilian Ceuca, ed., Manuela Franz, ed., Johann Nicolics, ed., [S. l., s. n.], 2013, 5 pp.
12. Petra Jenuš, Darja Lisjak, Danjela Kuščer, Darko Makovec, Mihael Drogenik, "Co-sintering of magnetoelectric composites of Co-ferrite and selected ferroelectrics", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 278-287.
 13. Milenko Pavlovič, Marina Santo-Zarnik, Sandi Kocjan, Marko Stušek, Darko Belavič, "Preliminary media-compatibility tests for LTCC-based pressure sensors", In: *Proceedings*, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 173-179.
 14. Tanja Pečnik, Sebastjan Glinšek, Brigita Kmet, Raluca C. Frunza, Barbara Malič, "Solution derived Ba_{0.5}Sr_{0.5}TiO₃ thin films on polycrystalline alumina substrates", In: *Proceedings*, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 235-238.
 15. Tanja Pečnik, Sebastjan Glinšek, Brigita Kmet, Barbara Malič, "Microstructure and kHz- and GHz- range dielectric properties of polycrystalline Ba_{0.5}Sr_{0.5}TiO₃ thin films", In: *2013 Joint UFFC, EFTF and PFM Symposium*, International Ultrasonics Symposium (IUS), Joint IEEE International Symposium on the Applications of Ferroelectrics (ISAF) and Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials (PMF), Joint International Frequency Control Symposium (IFCS), and European Frequency and Time Forum (EFTF), 21-25 July 2013, Prague, Czech Republic IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society International Ultrasonics Symposium (IUS), Joint IEEE International Symposium on the Applications of Ferroelectrics (ISAF) and Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials (PMF), Joint International Frequency Control Symposium (IFCS), and European Frequency and Time Forum (EFTF), 21-25 July 2013, Prague, Czech Republic, [S. l.], IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society, 2013, pp. 108-110.
 16. Katarina Vojisavljevič, Biljana Stojanović, Brigita Kmet, Jena Cilenšek, Barbara Malič, "Chemical synthesis of nanocrystalline CuAlO₂ via nitrate-citrate combustion route", In: *Slovenski kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, 7 pp.
 17. Marko Vrabelj, Hana Uršič, Brigita Rožič, Zdravko Kutnjak, Silvo Drnovšek, Barbara Malič, "Electrocaloric properties of 0.7Pb(Mg_{1/3}Nb_{2/3})O₃ - 0.3PbTiO₃ ceramics", In: *2013 Joint UFFC, EFTF and PFM Symposium*, International Ultrasonics Symposium (IUS), Joint IEEE International Symposium on the Applications of Ferroelectrics (ISAF) and Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials (PMF), Joint International Frequency Control Symposium (IFCS), and European Frequency and Time Forum (EFTF), 21-25 July 2013, Prague, Czech Republic IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society, 2013, pp. 310-312.
 18. Marko Vrabelj, Hana Uršič, Brigita Rožič, Zdravko Kutnjak, Silvo Drnovšek, Barbara Malič, "Electrocaloric properties of 0.7Pb(Mg_{1/3}Nb_{2/3})O₃ - 0.3PbTiO₃ ceramics prepared from mechanochemically activated powder", In: *Proceedings*, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 231-234.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Sebastjan Glinšek, Barbara Malič, Marija Kosec, "Low-temperature processing", In: *Chemical solution deposition of functional oxide thin films*, Theodor Schneller, et al, Dordrecht, Springer, 2013, pp. 431-444.
2. Marko Hrovat, Darko Belavič, Jena Cilenšek, "Thick-film resistor material: structural and electrical characteristics", In: *Resistors: theory of operation, behavior and safety regulations*, (Electrical engineering developments, Physics research and technology), Roy Abi Zeid Daou, ed., New York, Nova, 2013, pp. 17-36.
3. Danjela Kuščer, Zhijian Shen, "Advanced direct forming processes for the future", In: *Advanced ceramics for dentistry*, Zhijian Shen, ed., Tomaž Kosmač, ed., Amsterdam ... [et al.], Elsevier, 2013, pp. 375-390.
4. Barbara Malič, Sebastjan Glinšek, Theodor Schneller, Marija Kosec, "Mixed metallo-organic precursor systems", In: *Chemical solution deposition of functional oxide thin films*, Theodor Schneller, et al, Dordrecht, Springer, 2013, pp. 51-70.
5. Barbara Malič, Alja Kupec, Marija Kosec, "Thermal analysis", In: *Chemical solution deposition of functional oxide thin films*, Theodor Schneller, et al, Dordrecht, Springer, 2013, pp. 163-180.

PATENT APPLICATION

1. Urban Tomc, Andrej Kitanovski, Marko Ožbolt, Uroš Plaznik, Uroš Flisar, Jaka Tušek, Alojz Poredoš, Barbara Malič, Hana Uršič, Silvo Drnovšek, Jena Cilenšek, Zdravko Kutnjak, Brigita Rožič, *Method for electrocaloric energy conversion*, EP13179000.8, European Patent Office, 1.8.2013.

PATENT

1. Luca Gregoratti, Marco Peloi, Marija Kosec, Danjela Kuščer, Giuseppina Palma, *A material in the form of lithium fluoride powder containing colour centres, method for preparation and use thereof*, US8535434 (B2), US Patent Office, 17.9.2013.
2. Kostja Makarovič, Janez Holc, Darko Belavič, Marko Hrovat, Marija Kosec, *Multilayer ceramic structures for non-contact dielectric heating of liquids*, SI24008 (A), Urad RS za intelektualno lastnino, 30.8.2013.
3. Marina Santo-Zarnik, Darko Belavič, Marjan Hodnik, Sandi Kocjan, *A pressure-sensor module with a ceramic cantilever sensing structure*, SI24085 (A), Urad RS za intelektualno lastnino, 29.11.2013.

MENTORING

1. Jurij Koruza, *Sintering and phase transition behaviour of sodium niobate*: doctoral dissertation, Ljubljana, 2013 (mentor Barbara Malič; co-mentor Tadej Rojac).
2. Kostja Makarovič, *The effect of processing conditions on the phase composition, structure and properties of low temperature co-fired ceramics*: doctoral dissertation, Ljubljana, 2013 (mentor Andreja Benčan Golob; co-mentor Barbara Malič).

ENGINEERING CERAMICS DEPARTMENT

K-6

The Engineering Ceramics Department is the leading group in the field of structural ceramics and ceramic technologies in Slovenia. The research programme comprises phenomena relevant to materials synthesis and component fabrication as well as mechanisms leading to the degradation of engineering and bio-ceramic structures under operating conditions. The applied research work is focused on new applications of engineering ceramics, the development of novel, high-strength, wear-, corrosion- and/or heat-resistant materials and the development of alternative, cost-effective and environmentally friendly ceramic technologies.

Akin to previous years, in 2013 the investigation of AlN powder hydrolysis in diluted aqueous suspensions was continued. The established mechanistic model for aluminium hydroxide formation during the hydrolysis in a broad temperature range, i.e., between room temperature and the boiling point of water, which was published in 2012, was implemented with a study at 5 °C. The results revealed that throughout the two-week-long hydrolysis at this temperature the pH value of the suspensions was below 9, indicating the hydrolysis remained in the induction period. In parallel, a remarkably high value of dissolved aluminium species in the aqueous part of the suspension was detected, being an order of magnitude higher at a given pH value than the aqueous AlCl₃ solution. The work was accepted in the *Journal of American Ceramic Society*. These findings are also being tested in practice, since such supersaturated aluminate solutions could well serve as a new precursor for the precipitation of aluminium hydroxide-based thin films and nano-scaled particles in a procedure that could provide an alternative to the well-known sol-gel method.

In the field of electrically conductive ceramic composites we continued the research on the synthesis and properties of composites based on zirconia (Y-TZP) with dispersed titanium nitride (TiN) particles that could be machined with electrical-discharge machining. ZrO₂/TiN electro-conductive ceramic composites with various compositions were prepared by two approaches: the mixing of commercial powders and by in-situ precipitation (thermal hydrolysis), which under appropriate conditions enables the homogeneous distribution of TiN particles. The influence of parameters such as temperature, boiling time and pH on the crystallinity, polymorphic modification and size of the synthesized particles was investigated. Some effort was also invested into a study of the sintering behaviour of composites. A homogeneous powder mixture ZrO₂/TiN was prepared by the controlled precipitation of titanium oxide followed by calcination of the obtained powder mixture to titanium nitride by a thermochemical treatment (nitridation). The obtained powder mixture was densified with spark plasma sintering (SPS) to produce dense composites. The impact of the quantity and size distribution of the conducting phase on the concentration, density and electrical conductivity was further investigated. Moreover, the impact of the content and size of the conductive particles on the densification process and the final mechanical and electrical properties of the composites was also studied.

The research on the synthesis of electrically conductive ceramic composites based on silicon nitride was also re-initiated. Previously prepared Si₃N₄ powders coated with TiN or ZrN nanoparticles were this time sintered using the SPS technique. Since this method allows very high heating rates and fast densification compared to conventional sintering we wanted to show that it is possible to hinder the nanoparticles' growth, which was not possible before.

In 2013 the research on self-healing ceramic composites based on silicon nitride/silicon carbide composites was started. The silicon nitride ceramics with dispersed SiC nanoparticles was prepared by mixing the Si₃N₄ powder with polycarbosilane polymeric ceramic precursor, which forms SiC after



Head:
Prof. Tomaž Kosmač

Prof Tomaž Kosmač was a co-editor of the book *Advanced Ceramics for Dentistry*, issued in 2013 by Elsevier. The authors of many chapters were from the Engineering Ceramics department and other departments from the Jožef Stefan Institute.

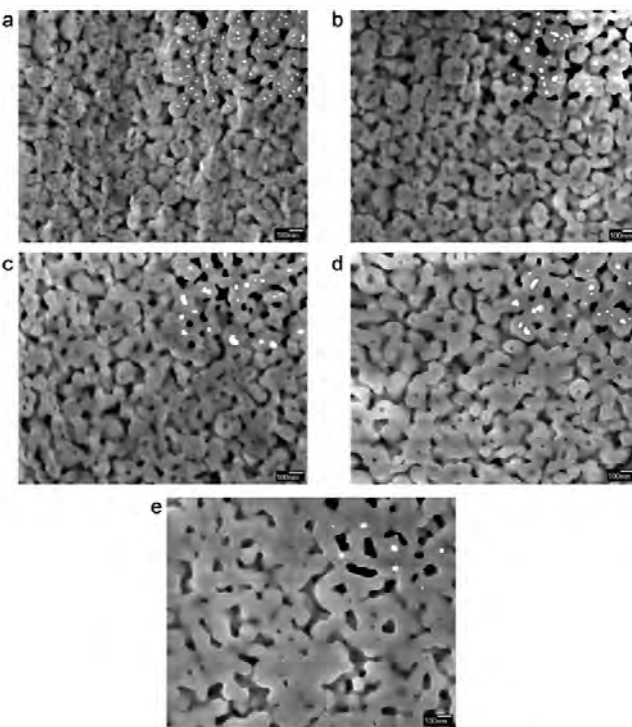


Figure 1: Scanning electron micrographs (SEM) showing the densification of mesoporous ZrO₂ with hierarchical heterogeneities in terms of pore packing.

pyrolysis. The powders were successfully densified using SPS, while the size of the SiC particles remained on the nanoscale. These materials exhibit better oxidation properties (and possible self-healing ability) compared to conventionally prepared $\text{Si}_3\text{N}_4/\text{SiC}$ composites.

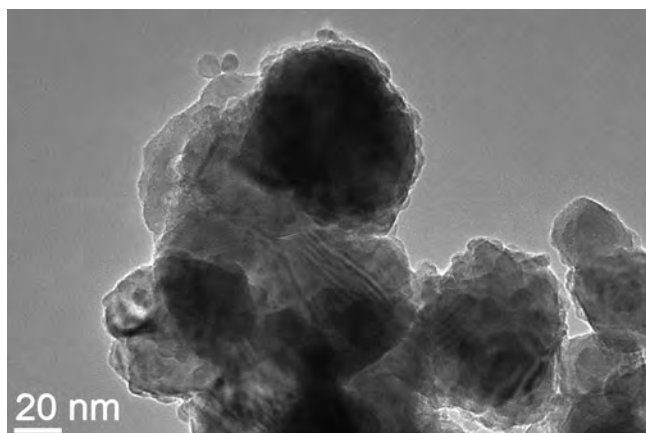


Figure 2: TEM micrograph of zirconia powder coated with TiN nanoparticles used for the preparation of electrically conductive engineering ceramics.

In the field of research on dental ceramics we continued by addressing some of the major problems concerning the production of full-ceramic dental contours with tetragonal zirconia (Y-TZP) as a core material, their cementation and their behaviour in clinical conditions. The work was conducted in close co-operation with the Department of Oral Medicine, Medical Faculty at the University of Ljubljana. In particular, we were interested in the role of phase partitioning within the grains, as well as that of stresses caused by the incorporation of aliovalent impurities on the grain boundaries, in the nucleation and growth of the monoclinic laths in the initial stage of ageing. In addition, accelerated ageing experiments with zirconia strips permanently loaded in bending during autoclaving were conducted in order to evaluate the influence of external stresses on the kinetics of the transformation during accelerated ageing. The combined effect of silica and alumina on the ageing resistance and mechanical properties of 3Y-TZP ceramics was evaluated. Specimens were prepared by the infiltration of a silica sol into the pre-sintered porous 3Y-TZP pellets, produced from commercially available powders, containing different amounts of alumina (0.05 and 0.25 wt. %). It

was found that the presence of silica in alumina-free 3Y-TZP greatly increases the resistance to ageing. The addition of small amounts of silica to alumina-containing 3Y-TZP further improves the ageing properties of t-zirconia, due to a possible distinctive mechanism of suppression, without affecting the flexural strength, Vickers hardness and indentation toughness. Finally, an in-vivo study aimed at monitoring the propagation of the t-m transformation of high-translucency 3Y-TZP ceramics directly exposed to the aggressive environment of the oral cavity in the absence of an externally applied stress has been started. Namely, according to most follow-up studies performed so far, the main reason for the repair or replacement of all-ceramic fixed partial dentures (FPDs) is porcelain chipping, which occurs much more frequently than the chipping of porcelain bonded to metal-ceramic FPDs. Since none of the numerous engineering concepts pursued worldwide in order to overcome the chipping problem proved to be sufficiently effective, an ever-larger number of frustrated clinicians is gearing towards porcelain-free crowns and bridges.

In our experiment, sintered zirconia discs, differing in their composition, microstructure and surface treatment, were implanted in the lingual flange of the lower dentures to be worn by recruited edentulous patients from the Department of Prosthodontics, Medical faculty, University of Ljubljana. After every 6 months the discs will be explanted, gently cleaned by ultrasonication to remove the adhered proteins and subjected to XRD and FE-SEM surface analyses. In order to evaluate the durability and reliability of “high translucent” Y-TZP ceramic, a series of full-anatomic four-unit posterior bridges was designed and soft-milled from commercially available zirconia blanks using a conventional CAD/CAM technique and sintered under different conditions (heating/cooling rate, end temperature, dwell time) to produce materials differing in the microstructure-related properties (damage tolerance, ageing behaviour). After glazing, they were subjected to mechanical fatigue testing under simulated clinical conditions. We were interested in compromise solutions between aesthetic design (thickness of the abutments and their transition to connectors) and durability for materials differing in sintering conditions and surface treatment. The results will be used in the material selection and denture design in the Department of Oral Medicine, University of Ljubljana. Yet another clinical testing has started in 2013 involving the surface functionalization of sintered zirconia by applying nanostructured adhesive coatings in a non-invasive process that has been recently developed in our group. The following two types of dentures were deemed most appropriate for the verification of nanostructured adhesive coatings in practice, because their long-term survival rate to a large extent depends on the adhesive bond strength and a stronger bonding than currently achievable would be very advantageous. These are: three-unit inlay-retained bridges replacing missing single premolars and molars that have become increasingly popular due to the conservative approach to prosthetic rehabilitation, and conical primary crowns supporting secondary galvano-crowns of removable partial dentures. Here again, volunteers were recruited among patients from the Department of Prosthodontics, Medical faculty, University of Ljubljana.

We have developed a novel method for the preparation of β -TCP coatings on ceramic bone implants with tailored physico-chemical properties, i.e., surface topography, mechanical strength and dissolution rate.

In 2013 dr. Andraž Kocjan ended his post-doctoral training at Stockholm University, where he was employed as a guest researcher. He was studying the processing and sintering of mesoporous zirconia (ZrO_2) ceramic powder. In the scope of this investigation his project entitled “Improved Reliability of Translucent Dental Zirconia and

Alumina Ceramics” was chosen and financed through a call - Frontiers of Research 2012 (JECS Trust foundation). The aim of the project was to prepare reliable and translucent ZrO₂ dental ceramics for full-contour dental restorations with no porcelain overlay. The project was successfully finalized and the results presented with an oral presentation entitled “*Processing of Advanced (Dental) Zirconia Ceramics*” at the ECERS XIII conference (Limoges, France). Parts of these results were published in the *Journal of European Ceramic Society*.

With the defence of a doctoral dissertation the research on the synthesis of bioactive calcium phosphate coatings on zirconia Y-TZP ceramics was successfully completed. The Y-TZP ceramics are frequently used in medicine as a material for dental implants due to their aesthetical and mechanical properties. The fixation of an implant can be improved as its surface is covered by bioactive calcium phosphate coating that forms a strong bond with bone tissue. The coatings were prepared using a biomimetic method in which the ceramic substrate is immersed in a solution with the same physiological temperature and similar composition as human blood plasma. The advantages of this bio-mimetic method are its simplicity, low price and good control of the composition of the coatings. One of the main problems that restrict the use of bio-mimetic coatings in medicine is the poor adhesion of the coatings to the substrate, so in the research we primarily dealt with ways of improving the mechanical properties of the coatings. It was found that the thermal treatment improved the adhesion of the coatings and at the same time it enables us the control of their phase composition. Thus, we have developed procedures for the synthesis of calcium phosphate coatings with different phase composition (hydroxyapatite, octacalcium phosphate, β -tricalcium phosphate), different morphology and mechanical properties. The procedure was described in an article published in the *Journal of European Ceramic Society*. Especially important is a new procedure for the synthesis of thin β -tricalcium phosphate coatings with very good mechanical properties. Mechanical tests showed that the adhesion of such coatings is comparable or even better than the adhesion of calcium phosphate coatings on commercially available bone grafts.

In the frame of the research on thermoplastic ceramic suspensions the new one-step thermal process for the removal of the binder from a low-pressure injection-moulded part and subsequent sintering was developed. This was done using high-purity carbon, since it enables the extraction of the binder from the samples and is afterwards burned out during the subsequent sintering process, which enables one-step thermal processing of the samples. The research was published in the *Ceramics International* journal.

With the company Hidria AET d.o.o. from Tolmin we cooperated in the field of maintenance and operational work in the field of centreless grinding of technical ceramics. We also cooperated with Institute of Ecological research ERICO in the field of the analysis of the particle size and distribution of materials that are transported to and from Luka Koper.

Some outstanding publications in the past three years

1. Gorjan, L., Kosmač, T., Dakskobler, A.: Single-step wick-debinding and sintering for powder injection molding. *Ceram. Int.* 2014 (available on-line 2013), vol. 40, issue 1, 887–891
2. Kocjan, A., Dakskobler, A., Budič, B., Kosmač, T.: Suppressed reactivity of AlN powder in water at 5°C. *Journal of the American Ceramic Society*, ISSN 0002-7820, 2013, vol. 94, issue 4, 1032–1034
3. Kocjan, A., Shen, Z.: Colloidal processing and partial sintering of high-performance porous zirconia nanoceramics with hierarchical heterogeneities. *Journal of the European Ceramic Society*, ISSN 0955-2219. [Print ed.], [in press] 2013, 12
4. Štefanič, M., Krnel, K., Kosmač, T.: Novel method for the synthesis of a β -tricalcium phosphate coating on a zirconia implant, *Journal of the European Ceramic Society*, 33 (2013) 3455–3465.
5. Kosmač, T., Kocjan, A.: Ageing of dental zirconia ceramics. *Journal of the European Ceramic Society*, ISSN 0955-2219. [Print ed.], 2012, vol. 32, issue 11, 2613–2622
6. Štefanič, M., Krnel, K., Pribošič, I., Kosmač, T.: Rapid biomimetic deposition of octacalcium phosphate coatings on zirconia ceramics (Y-TZP) for dental implant applications. *Appl. surf. sci.* [Print ed.], 2012, vol. 258, issue 10, 4649–4656
7. Kocjan, A., Ambrožič, M., Kosmač, T.: Stereometric analysis of nanostructured boehmite coatings synthesized by aluminum nitride powder hydrolysis. *Ceram. int.* [Print ed.], 2012, vol. 38, no. 6, 4853–4859

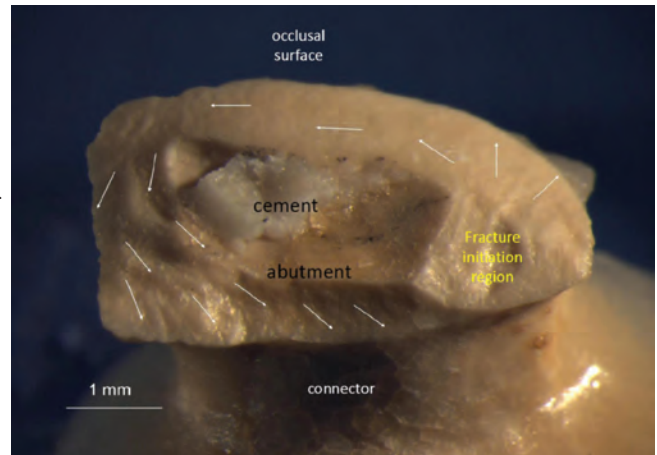


Figure 3: A general examination of the fracture surface using the optical microscope and by adjusting the lighting indicated that the fracture progressed as shown by the arrows.

In 2013 we cooperated with research institutions and industrial partners.

8. Kocjan, A., Dakskobler, A., Kosmač, T.: Evolution of aluminum hydroxides in diluted aqueous aluminum nitride powder suspensions. *Cryst. growth des.*, 2012, vol. 12, issue 3, 1299–1307
9. Gorjan, L., Dakskobler, A., Kosmač, T.: Strength evolution of injection-molded ceramic parts during wick-debinding. *J. Am. Ceram. Soc.*, 2012, vol. 95, issue 1, 188–193
10. Jevnikar, P., Golobič, M., Kocjan, A., Kosmač, T.: The effect of nano-structured alumina coating on the bond strength of resin-modified glass ionomer cements to zirconia ceramics. *J. Eur. Ceram. Soc.* [Print ed.], 2012, vol. 32, no. 11, 2641–2645
11. Stadler, Z., Krnel, K., Kovač, J., Kosmač, T.: Tribochemical reactions on sliding surface of the sintered metallic brake linings against SiC ceramic brake disk. *Wear.* [Print ed.], 2012, vol. 292/293, 232–238
12. Kocjan, A., Dakskobler, A., Krnel, K., Kosmač, T.: The course of the hydrolysis and the reaction kinetics of AlN powder in diluted aqueous suspensions. *J. Eur. Ceram. Soc.* [Print ed.], 2011, vol. 31, no. 5, 815–823
13. Gorjan, L., Dakskobler, A., Kosmač, T.: Partial wick-debinding of low-pressure powder-injection-moulded ceramic parts. *J. Eur. Ceram. Soc.*, 2011, vol. 30, no. 15, 3013–3021
14. Kocjan, A., Dakskobler, A., Kosmač, T.: Superhydrophobic nanostructured boehmite coatings prepared by AlN powder hydrolysis. *International journal of applied ceramic technology*, 2011, vol. 8, no. 4, 848–853
15. Gorjan, L., Dakskobler, A., Kosmač, T.: Strength evolution of injection-molded ceramic parts during wick-debinding. *J. Am. Ceram. Soc.*, 2011, vol. 95, no. 1, 188–193
16. Dakskobler, A., Kocjan, A., Kosmač, T.: Porous alumina ceramics prepared by hydrolysis-assisted solidification. *J. Am. Ceram. Soc.*, 2011, vol. 94, no. 5, 1374–1379
17. Pribošič, I., Beranič, S., Kosmač, T.: Biomimetic preparation and characterization of bioactive coatings on alumina and zirconia ceramics. *J. Am. Ceram. Soc.*, 2010, vol. 93, no. 1, 288–294
18. Perko, S., Dakskobler, A., Kosmač, T.: High-performance porous nanostructured ceramics. *J. Am. Ceram. Soc.*, 2010, vol. 93, issue 9, 2499–2502
19. Jevnikar, P., Krnel, K., Kocjan, A., Funduk, N., KKosmač, T.: The effect of nano-structured alumina coating on resin-bond strength to zirconia ceramics. *Dent. Mater.*, 2010, vol. 26, no. 7, 688–696

INTERNATIONAL PROJECTS

1. Services
Foreign buyers
Prof. Tomaž Kosmač
2. 7FP - CERAMPOL; Ceramic and Polymeric Membrane for Water Purification of Heavy Metal and Hazardous Organic Compound
European Commission
Prof. Tomaž Kosmač
3. COST MP1301; NEWGEN, New Generation Biomimetic and Customized Implants for Bone Engineering
COST Office
Prof. Tomaž Kosmač

RESEARCH PROGRAM

1. Engineering and Bio-Ceramics
Prof. Tomaž Kosmač

R&D GRANTS AND CONTRACTS

1. Research of Dental Ceramics
Prof. Tomaž Kosmač

VISITOR FROM ABROAD

1. Dr. Vaclav Pouchly, Central European Institute of Technology (CEITEC), Brno University of Technology, Department of Ceramics and Polymers, Brno, Czech Republic, 19. 8.–20. 11. 2013

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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Andraž Kocjan, Aleš Dakskobler, Bojan Budič, Tomaž Kosmač, "Suppressed reactivity of AlN powder in water at 523°C", *J. Am. Ceram. Soc.*, vol. 94, issue 4, pp. 1032-1034, 2013.
2. Andraž Kocjan, Zhijian Shen, "Colloidal processing and partial sintering of high-performance porous zirconia nanoceramics with hierarchical heterogeneities", *J. Eur. Ceram. Soc.*, vol. 33, iss. 15-16, str. 3165-3176, 2013.
3. Martin Štefanič, Kristoffer Krnel, Tomaž Kosmač, "Novel method for the synthesis of a β -tricalcium phosphate coating on a zirconia implant", *J. Eur. Ceram. Soc.*, vol. 33, 15/16, pp. 3455-3465, 2013.

REVIEW ARTICLE

1. Čedomir Oblak, Peter Jevnikar, Tomaž Kosmač, "Lastnosti in uporaba cirkonijske oksidne biokeramike v medicini", *Zdrav. Vestn.*, vol. 82, no. 12, pp. 825-836, 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

1. Tomaž Kosmač, "Survival-rate analysis of surface treated dental zirconia (Y-TYP) ceramics", In: *MiMe - materials in medicine, 1st edition, October 8-11, Faenza, Italy: conference guide, final program and abstract book*, [S. l., s. n.], 2013, pp. 135.

PUBLISHED CONFERENCE CONTRIBUTION

1. Anastasia Samodurova, Andraž Kocjan, Irena Pribošič, Tomaž Kosmač, "The effect of silica sol infiltration on the properties of dental 3Y-TZP ceramics", In: *Zbornik*, 5. študentska konferenca Mednarodne

podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 366-374.

2. Martin Štefanič, Kristoffer Krnel, Tomaž Kosmač, "Synthesis of bioactive β -TCP coating with tailored physico-chemical properties on zirconia bioc", In: *MiMe - materials in medicine, 1st edition, October 8-11, Faenza, Italy: conference guide, final program and abstract book*, [S. l., s. n.], 2013, pp. 143.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Corrado Piconi, Saverio Giovanni Condo, Tomaž Kosmač, "Alumina- and zirconia - based ceramics for load-bearing applications", In: *Advanced ceramics for dentistry*, Zhijian Shen, ed., Tomaž Kosmač, ed., Amsterdam ... [et al.], Elsevier, 2013, pp. 219-253.
2. Zhijian Shen, Tomaž Kosmač, "Advanced dental-restoration materials: concepts for the future", In: *Advanced ceramics for dentistry*, Zhijian Shen, ed., Tomaž Kosmač, ed., Amsterdam ... [et al.], Elsevier, 2013, pp. 343-358.
3. Martin Štefanič, Tomaž Kosmač, "Surface modifications of load-bearing ceramics for improved osseointegration", In: *Advanced ceramics for dentistry*, Zhijian Shen, ed., Tomaž Kosmač, ed., Amsterdam ... [et al.], Elsevier, 2013, pp. 301-325.

MENTORING

1. Martin Štefanič, *Bioactive calcium phosphate coatings on zirconia ceramics: doctoral dissertation*, Ljubljana, 2013 (mentor Tomaž Kosmač; co-mentor Kristoffer Krnel).

DEPARTMENT FOR NANOSTRUCTURED MATERIALS K-7

The basic and applied research in the Department for Nanostructured Materials includes ceramic materials, metals, intermetallic alloys and minerals. Our research encompasses conventional processing as well as the development of new technologies and methods for preparing new materials with novel properties. It includes experimental and theoretical investigations of structures, analyses of chemical compositions at the atomic level, and measurements and calculations of physical properties, all of which help us to improve the properties of micro- and nanostructured materials.



Head:
Prof. Spomenka Kobe

In 2013 we began work on the EU FP7 project “Nanocrystalline permanent magnets based on hybrid metal-ferrites” (NANOPYME). Our role is as the developer of 100-nanometer-scale Sr-ferrite particles via high-energy ball milling, with subsequent activities in the project related to the consolidation of two-phase exchange-coupled materials and the transfer of the process to the industrial partners, including Magneti Ljubljana d.d., during the final year of the project. The first 6-month meeting was held in Ljubljana during the last week of May 2013.

In the frame of ARRS-funded project “The protection of permanent magnets for advanced applications at high temperatures” we designed and developed an effective coating for magnets used at temperatures in the range of 400 °C. Multilayer coatings based on nickel and titanium nitride are proving to be very effective at these very high temperatures, resisting both corrosion and evaporation.

In another study, the so-called grain-boundary diffusion process (GBDP) was introduced. This is a post-sintering process, where the diffusion of Dy or Tb along grain-boundaries and into the outer parts of $\text{Nd}_2\text{Fe}_{14}\text{B}$ grains occurs and this contributes to a higher coercivity. The result is a “core-shell” microstructure where the core is represented by the Dy-free $\text{Nd}_2\text{Fe}_{14}\text{B}$ phase and the shell is rich in Dy ($\text{NdDyFe}_{14}\text{B}$). The first step that is needed in such a process is to coat the commercially available, Dy-free Nd-Fe-B sintered magnet with Dy-powder, in our case DyF_3 . The magnets were coated in two different ways. The first is by dip-coating and the second is by the more efficient electrophoretic deposition (EPD). The grain size of the DyF_3 -powder was in range of 5 μm to 60 μm and the suspension was based on ethanol. In the case of using EPD, the thickness of the DyF_3 -coating was varied from a few to 250 μm . After the coating-process, all the magnets were usually exposed to the same heat treatment at 850 °C for 10 hours and aging at 500 °C for 1 hour in an argon atmosphere. In this step, the so-called GBDP occurs. The magnetic measurements of such magnets were made with a permeameter. When rough calculations were made, to figure out how high is the Dy-concentration after GBDP, it was determined that in a whole magnet there is less than 1 wt. % of Dy and magnetic properties are even better or as good as in the case of magnet produced by the conventional powder metallurgy route that contain 2 wt. % of Dy. For this reason, GBDP based on EPD is an extremely attractive process that leads to a large coercivity improvement (up to 30 %) with only small drop in remanence. This work is part of the European project ROMEO (FP7-NMP-2012-SMALL-6) where one of the main goals is to reduce the usage of expensive heavy rare earths (Dy or Tb) in the NdFeB magnets and at the same time retain or even enhance the magnetic properties.

The deposition process of the Fe-Pd nanostructured alloys was kinetically evaluated and the parameters for an optimum composition depending on the system investigated, i.e., $\text{Fe}_{70}\text{Pd}_{30}$ or $\text{Fe}_{50}\text{Pd}_{50}$ was given. Magnetic shape memory $\text{Fe}_{70}\text{Pd}_{30}$ nanorods, which we are investigating in the frame of a national project with NIC and an MNT-ERA-NET project, were successfully deposited in a narrow composition range. Low-temperature SQUID measurements showed an increased magnetization saturation and coercivity,

In October 2013 we began coordinating a new EU FP7 project called “New permanent magnets for electric-vehicle drive applications” (MAG-DRIVE) to develop new processing technologies for rare-earth transition-metal magnets that will be incorporated into electric motors with higher efficiency. The project includes partners from the UK, Germany, Serbia, France and Slovenia. At the JSI, as well as coordinating the project we will be working on innovative compaction techniques such as spark-plasma sintering in an attempt to improve the magnetic properties by reducing as far as possible the grain growth inherent in high-temperature consolidation processes.

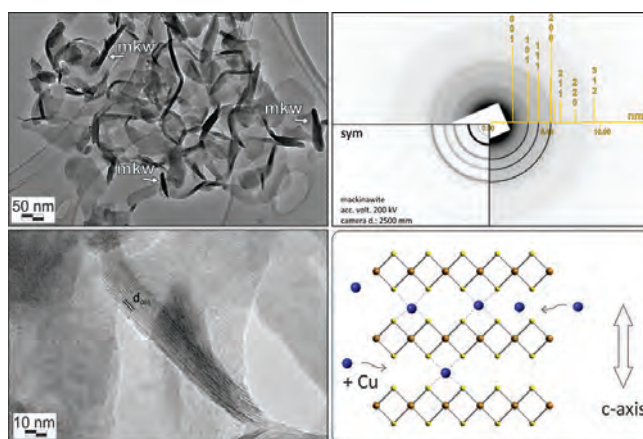


Figure 1: Agglomerates of mackinawite (FeS) leaves with corresponding experimental and simulated EPD. Individual mackinawite crystal with a mechanism of Cu incorporation between the mackinawite layers (TEM Jeol 2100).

Fe-Pd nanorods were successfully implemented in xerogels together with a model drug. The biocompatibility of the system was proven with an in-vivo experiment involving zebra fish. In the Fe₅₀Pd₅₀ nanorod system homogenous nanowires were deposited. A low magnetocrystalline phase in the as-deposited state was converted to the highly anisotropic L1₀ structure, exhibiting high coercivities H_c = 128 kA/m.

functional FePt-Au core/shell nanostructures suitable for novel magneto-photo medical curing. A suspension of FePt/SiO₂/Au core/shell nanoparticles in water was irradiated with a laser at the wavelength $\lambda=810\text{nm}$ ($P=1\text{W}$) suitable for curing humans. A significant temperature increment of the media surrounding the nanoparticles was detected.

We reported on nitrogen-filled hollow Co-Pt nanospheres produced via pulsed-laser ablation (PLA) in ambient nitrogen gas. In this study we have demonstrated that by applying PLA in an ambient nitrogen gas the gas-filled hollow Co-Pt nanospheres can be successfully produced, where the composition of the particles is controlled by the

Co-Pt target composition. By means of various techniques of transmission electron microscopy we aimed to characterize both the structure and the composition of synthesised nanospheres as well as to determine the nitrogen pressure inside the individual voids. The data was further employed for the reconstruction of the formation mechanism of Co-Pt gas-filled nanospheres and the suggestions for the general formation mechanism for gas-filled nanospheres in other metallic systems have been made.

Highly coercive permanent Nd-Fe-B-based magnets were successfully developed from commercially available MQU-F rapidly quenched ribbons with optimized composition by wet coating with DyF₃ in isopropanol and subsequent spark plasma sintering and heat treatment. The highest H_{ci} enhancement was obtained at 2.2 wt.% Dy-fraction, i.e., from 1580 to 2025 kA/m, which is a 25 % improvement. When more than 3 wt.% of Dy was added, the coercivity enhancement started to decrease, whereas at 4.8 wt.% the coercivity of the as-sintered magnet was lower than it was for the non-coated one and it was further decreasing with the annealing time. Based on the SEM results and the thermodynamic data on DyF₃ and NdF₃ formation enthalpies it appears that at a certain DyF₃ content a continuous NdF₃ layer starts to form that prevents Dy diffusion from the ribbons' interfaces. This explains an optimal addition of DyF₃. This innovative approach of manufacturing

fully dense Nd-Fe-B magnets with enhanced coercivity and a gradient microstructure was patented at the European Patent Office under patent number 1556. The research was performed within the scope of the EU project ROMEO.

We investigated the magnetic exchange interaction on the basis of Wannier orbitals obtained from electronic structure calculated ab initio. The so-determined parameters may be applied in the density-matrix-renormalization-group (DMRG) method, which is efficient mainly for one-dimensional systems. Within the framework of the density-functional theory we explored the possibilities for the presence of non-stabilities and complexities in the Ca-Ga-Cu phase diagram. We also determined the influence of beryllium on the twin-boundary energy in spinel.

In 2013 we broadened the research work of structural materials within the frame of the European fusion programme from ceramic composites SiC/SiC to tungsten-containing composites. For samples preparation we used the same processing technique as for the SiC/SiC and we investigated the influence of the tungsten content on the properties of the W-Si-C composites in the range of low and high tungsten content. The results have confirmed that by optimisation of the process, a relatively high strength can be achieved in both regions.

One of the important research topics is the electrophoretic deposition (EPD) of various materials. Among them, in 2013, the main attention has been paid to silicon carbide, carbon nanotubes and polymer polyether-etherketone (PEEK). The highest green densities were achieved from aqueous suspensions with a high solids loading (>40 wt. %) and with the optimal addition of surface-active agents, providing that the electrical conductivity is

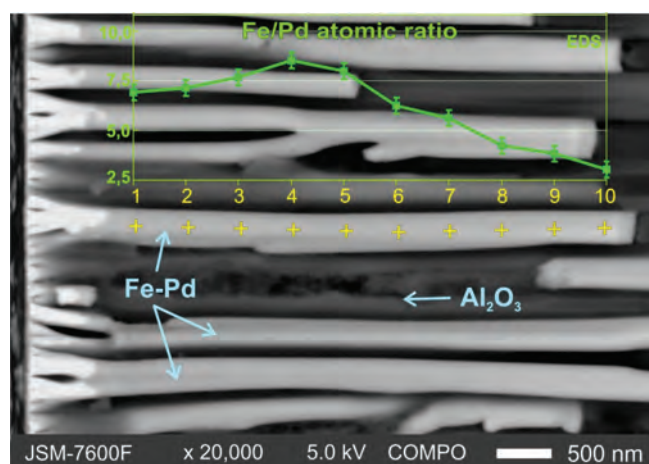


Figure 2: High-resolution FEGSEM micrograph of the Fe-Pd nanorods with superimposed diagram showing the variation of the atomic Fe/Pd ratio along the nanorod (points 1-10). The results were obtained from optimized low-voltage quantitative elemental EDS analysis with submicrometer analytical spatial resolution.

limited. Based on a comprehensive study of the deposits and suspensions before and after the deposition we explained the process for forming bulk SiC and PEEK parts.

In collaboration with Mechanical Engineer Faculty, UL, we were also dealing with the preparation of homogeneous PEE composites with nanoparticles (MoS_2 , WS_2 , CNT and graphene). The green parts were densified at various temperatures below and above the melting point and their wear properties were analysed. The results imply a significant influence of the processing temperature.

In the frame of the project BioTiNet (FP7-ITN) we continued with the analysis of the properties of anatase (TiO_2) coatings, grown by hydrothermal treatment on titanium alloys for bone-implant applications. In collaboration with the University of Barcelona, we confirmed the improved corrosion resistance of the coated alloys; moreover, we also verified the UV photo-induced properties of nanostructured TiO_2 coatings. The excellent photocatalytic activity of the firmly bonded coatings has been confirmed, as well as the UV photo-induced super-hydrophilicity, which appeared also as a prolonged effect (up to two weeks of recovery). In collaboration with the University in Sienna, the effect of the presence of the coating and its pre-irradiation with UV light on plasma protein adsorption have been studied, while in collaboration with the University of Giessen we verified the interaction with human cells. In continuation, the investigation will be completed by the analysis of the proposed bacteriostatic effect after UV pre-irradiation.

The investigations of materials for biomedical application involved the preparation and analysis of the scaffolds for hard-tissue engineering that is a topic of the COST action NAMABIO (From nano to macro biomaterials and applications to stem cells regenerative orthopaedic and dental medicine).

Within investigations of n-type oxide thermoelectric materials we synthesized Nb-doped SrTiO_3 . The basic microstructure of solid-solution $\text{Sr}(\text{Ti}_{0.8}\text{Nb}_{0.2})\text{O}_{3-x}$ was modified in two ways: with the addition of $\text{Sr}_3\text{Ti}_2\text{O}_7$ nucleation seeds and/or with the addition of SrO-excess. $\text{Sr}_3\text{Ti}_2\text{O}_7$ seeds were synthesized by molten salt approach. In the case when excess SrO was added to a $\text{Sr}(\text{Ti}_{0.8}\text{Nb}_{0.2})\text{O}_{3-x}$ solid solution we obtained material that was composed of two phases, namely, $\text{Sr}(\text{Ti}_{0.8}\text{Nb}_{0.2})\text{O}_{3-x}$ and polytypic Ruddlesden-popper phases. More or less ordered single planar faults with the SrO structure were also observed in the perovskite matrix. Measurements of thermoelectric properties of so far synthesized materials showed that the achieved a ZT value of approximately 0.12.

In the field of oxide thermoelectric materials we studied the influence of the sintering method (pulse electric current sintering - PECS, microwave sintering) and doping with oxides of Al, Mn, Fe, Ce and Nd on the structure, microstructure development and thermoelectric characteristics of ceramics in the system $(\text{ZnO})_x\text{In}_2\text{O}_3$ ($k = 5, 11$).

Perovskite materials such as SrTiO_3 nanostructures are suitable for many applications such as oxygen sensing and tunable HTS (high temperature superconducting) microwave filters. The potential advantages of the nanostructured forms have been, however, scarcely explored compared to other oxides. The synthesis of perovskite SrTiO_3 nanostructures via sol-gel electrophoretic deposition (EPD) into anodic aluminium oxide (AAO) membranes has proven to be very successful and useful. When measuring the electrical properties of SrTiO_3 nanotubes we obtained interesting scientific findings, which were published in the journal Materials Chemistry and Physics. In the article titled: "Insight into the structural, electrical and photoresponse properties of individual $\text{Fe}:\text{SrTiO}_3$ nanotubes" we reported on the structural and electrical properties of individual iron-doped strontium titanate nanotubes ($\text{Fe}:\text{SrTiO}_3$) grown by electrophoretic deposition (EPD). The $\text{Fe}:\text{SrTiO}_3$ nanotubes were assessed for the first time, showing high stability and reproducibility. This result paves the way to the further development of more complex titanate-based devices, as for instance nanostructured oxygen $\text{Fe}:\text{SrTiO}_3$ sensors. From the experimental data it was concluded that

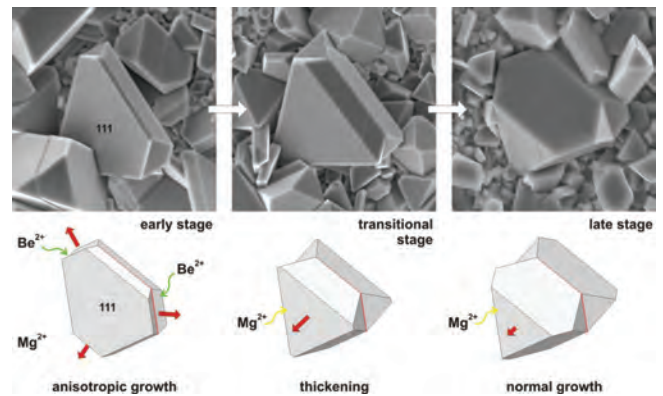


Figure 3: Development of (111) twin grains in MgAl_2O_4 spinel. Until the twin-boundary-forming dopant is available, the grains grow exaggeratedly along this boundary and consequently develop plate-like morphology unusual for the cubic spinel. Subsequently they thicken according to the normal grain growth Ostwald ripening law.

We prepared bioactive biodegradable scaffolds from composites of gellan gum reinforced with bioactive-glass nanoparticles, which helped to enhance the microstructure (pore size and interconnectivity), mechanical properties and formation of hydroxyapatite in simulated body fluid. Optimisation of the processing resulted in further improved mechanical properties by a better particles distribution in the polymer matrix and an increased amount of bioactive-glass reinforcement.

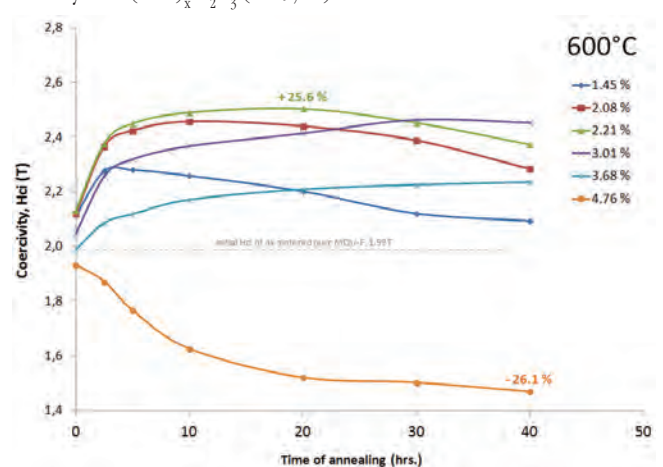


Figure 4: Coercivity dependence of spark plasma sintered and annealed MQU-F42 commercial alloy on addition of DyF_3 powder from isopropanol suspension

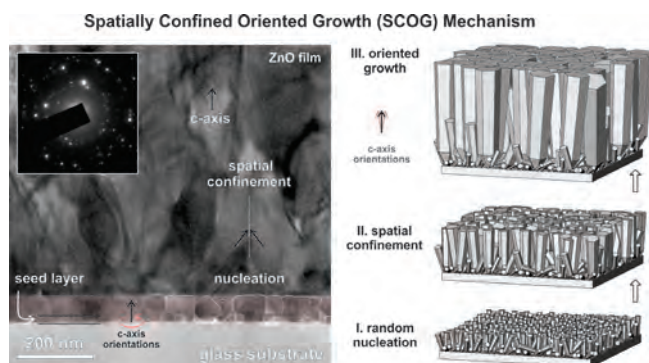


Figure 5: Cross-section TEM image of seed-layer and initial stages of film growth with illustrated SCOG mechanism. SCOG mechanism is expressed through three distinct growth stages: (i) random nucleation, (ii) spatial confinement, and (iii) oriented growth.

The influence of an organic vehicle and the amount of added varistor powder filler on the rheological characteristics of pastes and their screen-printing performance was studied. A paste with high solids load of 70% and good printing characteristics was developed and enables preparation of dense layers of varistor ceramics with good electrical characteristics at low sintering temperature of 900 °C, typical for the screen-printing hybrid circuit technology.

Applications involving **transparent conducting films (TCFs)**, such as flat-panel displays and touch screens technologies, are dominated by indium-tin-oxide (ITO). Increasing prices of indium makes a strong argument for alternative TCFs with competitive characteristics and lower price. We demonstrate the potential of highly oriented zinc oxide (ZnO) films grown on glass substrates under low-temperature hydrothermal (HT) conditions at 90 °C from aqueous solutions of Zn-nitrate and Na-citrate. Formation of a continuous ZnO seed-layer with proper thickness, grain size, connectivity and orientation of seed-grains on glass is shown to be essential to achieve conditions for the growth of highly oriented (0001), smooth, transparent and conductive ZnO films according to the spatially confined oriented growth (SCOG) mechanism. The film grown on a homogeneous seed-layer with grain size of about 20 nm showed optical transmittance of up to 82% and relatively low resistivity for undoped ZnO ceramic in order of few 100 Ω sq⁻¹. Such characteristics are explained by highly oriented crystalline texture and high coalescence of ZnO crystals in these films.

In collaboration with the company VARSİ we continued the development of special varistors for overvoltage protection of renewable energy systems (solar panels and wind turbine generators). The result is new types of varistors with high stability under dc field for operation under harsh climate conditions (temperature, humidity).

In the development of cost-effective and **environment friendly photo-voltaic systems** the Cu₂ZnSnS₄-type films (CZTS) showed very promising. CZTS is p-type semiconductor with preferred optical band gap at 1.5eV and high absorption coefficient made of well abundant and hence cheap elements, which are also nontoxic. We studied preparation of CZTS films by sol-gel spin coating and annealing in sulphur-rich atmosphere at 500°C on flexible metal substrates of Al, Ti, Cu and Mo.

In the field of **photocatalysis** we designed and fabricated Ti-foil based microreactor with titania nanotubes and anatase nanoparticles. Basic photocatalytic properties and design was published in ACS applied materials & interfaces (IF 5). Using this microreactor we performed series of experiments where we studied the mechanisms of degradation reactions for various types of organic substances. It was found that during the decomposition of organics containing chlorine the efficiency of the microreactor seriously decreased. With EPR measurements we tried to establish the mechanism of this phenomena, namely the chlorine could adsorb on the surface of nano-anatase particles and due to steric effects hindered the adsorption of the organic molecules or could produce chlorine radicals which are concurrent

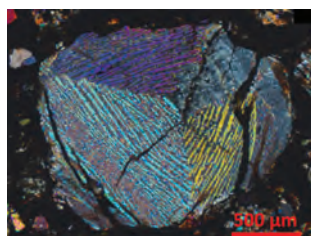


Figure 6:
Left - meteorite Jezersko (mass 1380 g)
Right - Typical barred olivine chondrule observed in cross-polarized light

the polycrystalline form of Fe:SrTiO₃ nanotubes is the major limitation to attain high photoconductivity gains when exposed to UV-light.

We optimized parameters for the anodization of aluminium alloys. The obtained oxide layer was coloured by selected ion. In the case of copper ions we obtained a purple colour of oxide layer. This work was performed in cooperation with the department of thin films and surfaces (F3) and Impol industry.

In the field of **dye-sensitized solar cells (DSSCs)** we focused our research on the fabrication of high-efficient photo-anodes composed of TiO₂ nanotubes. A self-ordered, vertically aligned TiO₂ nanotubes, were grown on electropolished titanium foil by anodic oxidation in viscous organic electrolyte. By changing the anodization parameters (temperature, time, applied voltage, electrolyte composition) TiO₂ nanotube arrays with different morphologies were obtained. Some of the TiO₂ nanotubes were additionally treated with TiCl₄ or with TiO₂ P25. The prepared photo-anodes were assembled into flexible and nonflexible DSSCs. Measured current-voltage characteristics showed that the maximum energy conversion efficiency for flexible DSSCs was 2.1% and for nonflexible 5.9%.

We developed homogeneous coarse-grained low-voltage **ZnO-based varistor ceramics** doped with Bi₄Ti₃O₁₂ or Bi₁₂TiO₂₀ and other varistor dopants having breakdown voltage in the range from 20 to 40V/mm and nonlinearity coefficient α above 20. The development was based on the discovery that rapid decomposition of pre-reacted phases from the Bi₂O₃-TiO₂ system into TiO₂-rich Bi₂O₃ liquid phase enhances formation of inversion boundaries in the ZnO grains, which results in homogeneous grain growth and microstructure development.

Applications involving **transparent conducting films (TCFs)**, such as flat-panel displays and touch screens technologies, are dominated by indium-tin-oxide (ITO). Increasing prices of indium makes a strong argument for alternative TCFs with competitive characteristics and lower price. We demonstrate the potential of highly oriented zinc oxide (ZnO) films grown on glass substrates under low-temperature hydrothermal (HT) conditions at 90 °C from aqueous solutions of Zn-nitrate and Na-citrate. Formation of a continuous ZnO seed-layer with proper thickness, grain size, connectivity and orientation of seed-grains on glass is shown to be essential to achieve conditions for the growth of highly oriented (0001), smooth, transparent and conductive ZnO films according to the spatially confined oriented growth (SCOG) mechanism. The film grown on a homogeneous seed-layer with grain size of about 20 nm showed optical transmittance of up to 82% and relatively low resistivity for undoped ZnO ceramic in order of few 100 Ω sq⁻¹. Such characteristics are explained by highly oriented crystalline texture and high coalescence of ZnO crystals in these films.

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to hydroxyl radicals. The photocatalysis of zinc oxide as a function of crystallinity and particle size was also studied and published in Applied Catalysis. B, Environmental (IF 5,8).

Self-assembly of Ge, Ni and Co quantum dots in amorphous silica matrix after the high-energy ions irradiation was investigated using electron microscopy and microanalysis. With co-workers we published series of 4 papers on self-organization of quantum dots. With the synthesis parameters we were able to prepare different superstructures. In collaboration with scientists from Portugal the influence of carbon nano-tubes addition to TiO_2 and morphologies of titania on photocatalytic degradation of caffeine were explained in papers published in Catalysis Today.

We synthesized and further investigated Cu-doped Fe-sulphides. With electron microscopy, X-Ray diffraction and magnetic measurements we showed the influence of copper on the first precipitate and on the subsequent phase transformations in FeS system. TEM investigation of Cu-doped mackinawite-like FeS showed enhanced crystallinity accompanied with expansion of the unit cell along the c-axis, proportional to the amount of Cu adsorbed between the (001) layers of the mackinawite structure. The subsequent solvothermal treatment and sulphurization of undoped FeS resulted in formation of pyrite, at low doping Cu-rich mackinawite and cubic (Fe,Cu)S with a sphalerite-type structure were formed, while at higher Cu concentrations the end-products were chalcopyrite and bornite, corresponding to the initial amount of Cu in the reagents. These mackinawite properties can be also used for sorption of Cu, Ni or Cr from degraded environment. The results of work were published in two scientific articles.

In the frame of the basic research project 'Twinning, epitaxies and phase transformations in minerals' we continued with nanostructural investigations of growth-type transformational defects in different systems. In the spinel-chrysoberyl system we confirmed our hypothesis that twinning in MgAl_2O_4 spinel is triggered by the addition of BeO. The results of this work are published in CrystEngComm (IF 3.879). In the rutile-hematite system we studied the mechanism of topotaxial transformation of ilmenite to rutile and hematite. These minerals are related through a common close-packed oxygen sublattice. While ilmenite and hematite have a rhombohedral symmetry, the rutile lattice is slightly tetragonally distorted. Under certain conditions, ilmenite transforms (oxidises) to rutile and hematite, where rutile lamellas precipitate along structurally defined crystal planes of the precursor and finally form reticulated network also known as sagenite. The products of ilmenite oxidation are common in nature and the reaction is also of technological importance for the production of rutile from ilmenite precursor. In the previous year we finished a study of topotaxial rutile-hematite intergrowths from the locality Mwinilunga in Zambia, where we determined the crystallographic relationship between rutile and hematite and suggested a mechanism of their formation based on an extensive transmission electron microscopy study. A manuscript for the journal 'Contributions to Mineralogy and Petrology' is in preparation. In addition we started a detailed study of the ilmenite to rutile/hematite transformation mechanism at the atomic level. For this purpose we performed thermal or hydrothermal treatment of natural single crystals of ilmenite. The results show that different transformation mechanism exists based on the treatment technique. During hydrothermal treatment, transformation is based on the dissolution-precipitation mechanism, while during thermal treatment; the recrystallisation is based on the internal rearrangement of atomic within the rigid oxygen sublattice.

Up to date three meteorites have been found on the territory of Slovenia, one stony and two iron types. The highly conserved stone meteorite named after the location Jezersko has recently joined to the collection of Slovenian meteorites. The detailed studies of the meteorite Jezersko, which were performed jointly at the Jožef Stefan Institute, Geological Survey of Slovenia, Faculty of Natural Sciences and the Museum for Natural History of Slovenia offers us an unique opportunity for in-depth understanding of the origin and evolution of our solar system in the last ~ 4.6 billion years. **Meteorite Jezersko** was registered into the database of all known meteorites in Lunar and Planetary Institute (Meteoritical Bulletin Database).

Within the ARRS project J2-4237 we have investigated the innovative materials using advanced methods of high-resolution scanning electron microscopy (FEGSEM) and quantitative elemental analyses by energy-dispersive and wavelength-dispersive X-ray spectroscopies (EDS, WDS). These methods were modified and improved for reliable materials characterization on submicrometer and nanometre-scale. Using the electron backscatter diffraction (EBSD) analysis we have investigated the crystallinity and the presence of quasicrystals in complex metallic alloys based on Al and Gd-Cu-Ca.

For industrial partners and other research institutions we have performed the analyses and expertise related to microstructural characterization of various materials which were included in

We successfully synthesised simple and complex twins of spinel, which proved that the ccp-hcp transformation is caused by the presence of beryllium at the (111) twin boundaries. At higher BeO additions we observed the formation of epitaxial overgrowths of spinel with $\text{BeMg}_3\text{Al}_8\text{O}_{16}$ taaffeite-type compounds. This finding has a potential applicative value since twinned spinel grains develop a plate-like morphology that may improve the mechanical properties of spinel-based ceramics.

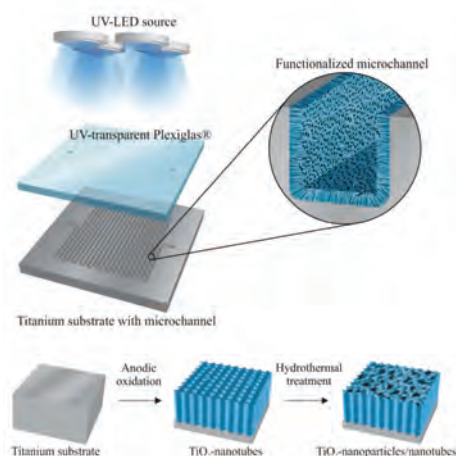


Figure 7: Schematic presentation of photocatalytic microreactor and its design and fabrication

Members of the department have also been active in the promotion of science. In 2013 we presented some of the achievements in the TV programme “Bite the Science”. Under the umbrella of the Slovenian Society for Science and Engineering (SATENA) we organised the first two sets of popular lectures on science for general public (“Science on the street, knowledge and ideas on the go”).

the research and development of new products. Main collaborations were realized with SwatyComet Maribor, Cinkarna Celje, Belinka Ljubljana, ULNTF Department of Materials and Metallurgy, Ljubljana, RC SIMIT Kidričevo, Ortopedska Bolnišnica Valdoltra Ankaran.

One of the important research areas of the group is the implementation of various electron microscopy analytical techniques within the existing EU project ESTEEM2, such as electron energy-loss spectroscopy (EELS), high-resolution scanning transmission electron microscopy (STEM, HAADF-STEM) electron holography and mechanical preparation of the TEM samples. The research group is additionally strongly involved in managing of the Center for Electron Microscopy within the frame of the National Infrastructure Center

for microstructural and surface analysis. Implementation of various electron microscopy analytical techniques and the possibility for researchers to access research infrastructure for electron microscopy is of utmost importance for numerous research institutions, industrial partners, as well as for graduate and post-graduate education.

Awards and appointments

1. Saša Novak Krmpotič, State (Zois) recognition of scientific achievements in the field of materials, Ljubljana, 22. 11. 2013
2. Nina Kostevšek, Kristina Žužek Rožman, Sašo Šturm, Spomenka Kobe, “Hybrid FePt/Au Nanoparticles With a Combined Magneto-Photothermal Effect”, The best presentation among young researchers in the research field Nanomaterials and Nanotechnology, 21st Conference on Materials and Technology, Portorož, Slovenia, 13.-15. 11. 2013
3. Marja Jerič, Miran Čeh, “Molten salt synthesis of Nb-doped $\text{Sr}_3\text{Ti}_2\text{O}_7$ platelet seeds”, The best poster among young researchers in the research field Nanomaterials and Nanotechnology, 21st Conference on Materials and Technology, Portorož, Slovenia, 13.-15. 11. 2013
4. Medeja Gec, Matic Krivec, Kristina Žagar, Luka Suhadolnik, Darja Jenko, Goran Dražič, Miran Čeh, “Comparison of TEM lamella preparation techniques on titania nanotube-arrays/metal Ti interface”, MC2013 Best poster award in Instrumentation and Methods, at the MC2013 Microscopy Conference, Regensburg, Germany, 25.-30. 8. 2013
5. Sandra Drev, Aleksander Rečnik, Nina Daneu, “Twinning and inclusions in chrysoberyl from Pratinhas, Brazil”, MC2013 Best poster award in Materials science at the MC2013 Microscopy Conference, Regensburg, Germany, 25.-30. 8. 2013

Organization of conferences, congresses and meetings

1. 1st CalGadX Conference, Ljubljana, Slovenia, 12.-13. 12. 2013
2. 21st International Conference on materials and Technologies, Portorož, Slovenia, 13.-15. 11. 2013 (co-organisation)
3. C-MAC Days 2013, Ljubljana, Slovenia, 9.-12. 12. 2013 (members of Science Board and General Assembly in European integrated Center for the Development of New Metallic Alloys and Compounds (C-MAC))
4. EMAS 2013, 13th European Workshop on Modern Developments and Applications in Microbeam Analysis Porto, Portugal, 14.-18. 5. 2013 (members of Managing Board of European Microbeam Analysis Society)
5. Microscopy Conference 2013, MCM2013, Regensburg, Germany, 25.-30. 8. 2013 (members of International Advisory Board)
6. Fusion Expo: The Big Bang, UK Young Scientists & Engineers Fair, London, United Kingdom, 14.-17. 3. 2013 (co-organisation)
7. Fusion Hands on experiments at ECSITE Annual Conference, Gothenburg, Sweden, 6.-8. 6. 2013 (co-organisation)
8. Fusion Expo: Science Days 2013, Rust, Germany, 10.-12. 10. 2013 (co-organisation)
9. Fusion Expo: Scientific Festival Week of Science and Technology 2013, Prague, Czech Republic, 1.-15. 11. 2013 (co-organisation)
10. Fusion Expo: Campus Drie Eiken, Antwerpen, Belgium, 21.-22. 11., 26.-27. 11. 2013 (co-organisation)

INTERNATIONAL PROJECTS

- Services for the Exports
Foreign Clients
Dr. Zoran Samardžija
- 7FP - MACAN; Merging Atomistic and Continuum Analysis of Nanometer Length-scale Metal-oxide Systems for Energy and Catalysis Applications
European Commission
Asst. Prof. Aleksander Rečnik
- 7FP - 2020 Interface; Nanoscale of Tribological Interfaces for Clean and Energy-Efficient Diesel and Gasoline Power Trains
European Commission
Asst. Prof. Matej Andrej Komelj
- 7FP - BioTiNet; Academic-Industrial Initial Training network on Innovative Biocompatible Titanium-based Structures for Orthopaedics
European Commission
Prof. Spomenka Kobe
- 7FP - ESTEEM 2; Enabling Science and Technology through European Electron Microscopy
European Commission
Prof. Miran Čeh
- 7FP - NANOPYME; Nanocrystalline Permanent Magnets Based on Hybrid Metal-Ferrites
European Commission
Asst. Prof. Paul John McGuinness
- 7FP - Fusion Expo; Fusion Expo Support Action under EFDA Work Programme, Task Agreement WP10-PIN-FUSEX
Ministry of Education, Science and Sport
Asst. Prof. Saša Novak Krmpotič
- 7FP - EURATOM; Review R&D on Materials - 4.1.1.2., WP11-DAS-MAT-M03-01/MHEST/PS
Ministry of Education, Science and Sport
Asst. Prof. Saša Novak Krmpotič
- 7FP - ROMEO, Replacement and Original Magnet Engineering Options
European Commission
Prof. Spomenka Kobe
- 4.1.1.-FU, EURATOM-MHEST; Development of W-Containing Composites
Ministry of Education, Science and Sport
Asst. Prof. Saša Novak Krmpotič
- 4.1.2.-FU, EURATOM-MHEST; Development of W-Containing Composites
Ministry of Education, Science and Sport
Asst. Prof. Saša Novak Krmpotič
- 7FP - MAG-DRIVE; New Permanent Magnets for Electric-Vehicle Drive Application
European Commission
Asst. Prof. Paul John McGuinness
- MODEF - Creazione e Sperimentazione Congiunta di Modelli per l'Ottimizzazione dell'Utilizzo di Energia Fotovoltaica
Unindustria Rovigo
Dr. Zoran Samardžija
- COST MP1005, NAMABIO; From Nano to Macro Biomaterials (Design, Processing, Characterization, Modelling) and Applications to Stem Cells Regenerative Orthopedic and Dental Medicine
COST Office
Asst. Prof. Saša Novak Krmpotič
- Minerals as a Precursors for Advanced Technologies
Slovenian Research Agency
Asst. Prof. Nina Daneu
- Microstructural Investigation of Materials for Hydrogen Storage and Correlation with Desorption Properties
Slovenian Research Agency
Asst. Prof. Sašo Šturm
- Experimental and Theoretical Investigation of Hydrogen Sorption in Mg-Zr-Fe-Ni and Ti-Fe-Ni Systems
Slovenian Research Agency
Dr. Andraž Kocjan
- The CALGAD-X Project: New Calcium-Gadolinium-X Complex Metallic Alloys
Slovenian Research Agency
Prof. Spomenka Kobe
- Study of Chemical Strain in Perovskites Doped With Aliovalent Cations by Applying In-Situ X-Ray Diffraction, Dilatometry and Advanced Transmission Electron Microscopy Techniques
Slovenian Research Agency
Asst. Prof. Sašo Šturm

RESEARCH PROGRAM

- Nanostructured Materials
Prof. Spomenka Kobe

R&D GRANTS AND CONTRACTS

- New Metallic Materials for Thermal Storage of Digital Information
Dr. Andraž Kocjan
- Near-net Shape Nanoparticle-Reinforced Polymer-Composites for Highly-Loaded Advanced Mechanical Components with Superior Tribological Performance
Asst. Prof. Saša Novak Krmpotič
- Novel Functionalized Nanomaterials for Applications as Nano- or Biosensors/Actuators/Bioresponsive (Carrier) Systems
Asst. Prof. Kristina Žužek Rožman
- Twinning, Epitaxy and Phase Transformations in Minerals
Asst. Prof. Nina Daneu
- Electron Microscopy and Microanalysis of Materials on Submicrometer scale
Dr. Zoran Samardžija
- Hydrothermal Synthesis of Strongly Adhered TiO₂ Photocatalytic Coatings on Metallic Substrates
Asst. Prof. Goran Dražič
- Microbial Adhesion Management on Material Surfaces
Asst. Prof. Goran Dražič
- Development of the Model of the System for Intelligent Support of the Selection of Suitable Powder Material when Developing Sintered Products
Asst. Prof. Saša Novak Krmpotič
- Modification of TiO₂ Nanoparticle Surface: Prevention of Agglomeration and Preservation of Intrinsic Properties
Asst. Prof. Aleksander Rečnik
- Innovative Production Systems for Vaccines and Regenerative Medicine
Asst. Prof. Aleksander Rečnik
- High-coercivity Nd-Fe-B Bonded Magnets for Automotive Applications
Prof. Spomenka Kobe
- Protected Permanent Magnets for Advanced High-Temperature Applications
Asst. Prof. Paul John McGuinness
- Materials and Technologies for Applications of ZnO-based Thick Film Varistors and Oxide Thermoelectrics
Asst. Prof. Slavko Bernik
- Colour, Absorption and Protective Nanolayer Coatings for Aluminium alloy
Prof. Miran Čeh
- NSFM: Novel Smart Filtration Media
Asst. Prof. Kristina Žužek Rožman
- Advanced Methods and Technologies for Processing of a New Generation of ZnO-based Varistor Ceramics
Asst. Prof. Slavko Bernik
- Irradiation and Analysis of Si Samples
Asst. Prof. Saša Novak Krmpotič
- MODEF - Creazione e Sperimentazione Congiunta di Modelli per l'Ottimizzazione dell'Utilizzo di Energia Fotovoltaica
Dr. Zoran Samardžija

NEW CONTRACTS

- The Study of Self-cleaning and Abrasion Resisting Properties of Carbon-, Para-aramid- or Glass-fibre-based Composite Materials by Applying Photocatalytic and/or Mechanical Resistant Nanoparticles
Asst. Prof. Sašo Šturm
- Multipole Magnetisation of NdFeB Bonded Magnets for Rotor Application
Prof. Spomenka Kobe
- Cofinancing of the L2-4097 Application Project: High-coercivity Nd-Fe-B Bonded Magnets for Automotive Applications
Prof. Spomenka Kobe
- Cofinancing of the L2-4192 Application Project: Materials and Technologies for Applications of ZnO-based Thick Film Varistors and Oxide Thermoelectrics
Asst. Prof. Slavko Bernik
- Cofinancing of the L2-4099 Application Project: Protected Permanent Magnets for Advanced High-Temperature Applications
Asst. Prof. Paul John McGuinness

VISITORS FROM ABROAD

1. Prof. Bojana Obradović, Prof. Vesna Misković-Stanković, Jovana Zvicer, Tehnološko-metalurški fakultet, Univerzitet u Beogradu, Belgrade, Serbia, 25. 1. 2013
2. Prof. Hiroshige Kikura, Tokyo Institute of Technology, Tokyo, Japan, 25. 2. 2013
3. Dr. Meltem Sezen, Sabanci University, Nanotechnology Research and Application Center, Istanbul, Turkey, 17.-22. 3. 2013
4. Dr. Guorong Li, Chinese Academy of Science, Shanghai, China, 3.-7. 4. 2013
5. Samed Cetinkaya, Technology and R&D Application and Research Center, Mustafa Kemal University, Hatay, Turkey, 4. 4.-31. 12. 2013
6. Xiangkai Xiao, Chinese Academy of Science, Shanghai Institute of Ceramics, Shanghai, China, 3. 4.-30. 9. 2013
7. Prof. Jean-Marie Dubois, Institut Jean Lamour, Nancy, France, 20.-27. 2. 2013
8. Enrico Catalano, University of Piemonte Orientale "A. Avogadro", Laboratory of Biomedical and Dental Materials, Novara, Italy, 22. 4.-24. 5. 2013
9. Dr. Branko Matović, Institut za nuklearne nauke Vinča, Beograd, Serbia, 28. 4.-4. 5. 2013
10. Dr. Jakub Michalski and Marta Bojarska, Wydział Inżynierii Materiałowej Politechniki Warszawskiej, INMAT, Warsaw, Poland, 9. 5. 2013
11. Prof. Boštjan Markoli, Dr. Iztok Naglič, Faculty of Natural Sciences, University of Ljubljana, 9. 5. 2013
12. Alessia Bolla, Politecnico di Torino, Torino, Italy, 25. 5.-28. 7. 2013
13. Dr. Cesar de Julian Fernandez, Dr. Claudio Sangregorio, Dr. Elisabetta Lottini, Dr. Alberto Lopez Ortega, Consorzio interuniversitario nazionale per la scienza e tecnologia dei materiali - INSTM, Florence, Italy, 30.-31. 5. 2013
14. Dr. Alberto Boller, Maria Jesús Villa, Dr. Julio Camarero, The Institute for Advanced Studies in Nanoscience - IMDEA, Madrid, Spain, 30.-31. 5. 2013
15. Dr. Irena Škulj and Uroš Bavdek, Magneti d.d. Ljubljana, Ljubljana, Slovenia, 30.-31. 5. 2013
16. Judit Almunia, Dr. Ana Belen Seoane, Ingeniería magnética aplicada s.l. - IMA s.l., Barcelona, Spain, 30.-31. 5. 2013
17. Prof. José Francisco Fernández, Dr. Adrián Quesada, Agencia estatal consejo superior de investigaciones científicas - CSIC, Madrid, Spain, 30.-31. 5. 2013
18. Dr. S. Erokhin, Dr. Dimitri Berkov, Verein zur förderung von innovation durch forschung, entwicklung und technologietransfer e.v. - INNOVENT, Jena, Germany
19. Dr. Mogens Christensen, Aarhus universitet - AU, Aarhus, Denmark, 30.-31. 5. 2013
20. Dr. Matylda Guzik, Dr. Stefano Deledda, Institut for energiteknikk - IFE, Kjeller, Norway, 30.-31. 5. 2013
21. Dr. Bogi Bech Jensen, Muhammad Fasil, Danmarks Tekniske Universitet - DTU, Kongens Lyngby, Denmark, 30.-31. 5. 2013
22. Dr. Pilar Marin, Ana Aragón, Universidad Complutense de Madrid - UCM, Madrid, Spain, 30.-31. 5. 2013
23. Prof. Jean-Marie Dubois, Institut Jean Lamour, Nancy, France, 5.-10. 5. 2013
24. Prof. Nazanin Emami, Arash Golchin, Fatima Nowshir, Silvia Suner, Stephan Schnabel, Alaleh Safari, Jorge Rituerto, Jinxia Li, Lule tekniska universitet, Lule, Sweden, 4. 6. 2013
25. Prof. Werner Mader, Institut für Anorganische Chemie - Universität Bonn, Bonn, Germany, 31. 7.-11. 8. 2013
26. Prof. Jean-Marie Dubois, Institut Jean Lamour, Nancy, France, 25.-28. 8. 2013
27. Dr. Claudia Silva, Faculdade de Engenharia da Universidade do Porto - FEUP, Porto, Portugal, 23.-27. 9. 2013
28. Dr. Adrian Silva, Faculdade de Engenharia da Universidade do Porto, Departamento de Engenharia Química, Porto, Portugal, 20.-25. 8. 2013
29. Dr. Mehmet Ali Gülgün, Dr. Cleva Ow-Yang, Sabanci University, Istanbul, Turkey, 18.-23. 9. 2013
30. Prof. Peter van Aken, Max-Planck-Institut Stuttgart, Stuttgart, Germany, 19.-20. 9. 2013
31. Prof. Joachim Kleebe, Dr. Marc Rubat du Merac, Technische Universität Darmstadt, Darmstadt, Germany, 9.-12. 10. 2013
32. Dr. Gerhard Niedermayr, Rudolf Hartmann, Naturhistorisches Museum Wien, Vienna, Austria, 16.-17. 10. 2013
33. Dr. Allan Walton, Dr. Vicky Mann, Magnetic Materials Group (MMG), Metallurgy and Materials, University of Birmingham, Birmingham, United Kingdom, 1. 10. 2013
34. Dr. Katarina Čirić, Dr. Jana Radaković, Institut of Nuclear Sciences Vinča, Belgrade, Serbia, 12.-17. 11. 2013
35. Prof. Mihály Pósfai, University of Veszprem, Veszprem, Hungary, 20. 11. 2013
36. Prof. Monica Ferraris, Politecnico di Torino, Torino, Italy, 15. 11. 2013
37. Prof. Jean-Marie Dubois, Institut Jean Lamour, Nancy, France, 5.-12. 10. 2013
38. Dr. Nikola Novaković, Dr. Jasmina Grbović Novaković, Dr. Ljiljana Matović, Sandra Kurko, Institut of Nuclear Sciences Vinča, Belgrade, Serbia, 29. 10.-4. 11. 2013
39. Prof. Jean-Marie Dubois, Dr. Vincent Fournée, Dr. Julien Ledieu, Dr. Emilie Gaudry, Dr. Merie-Cecile De Weerd, Dr. Pascal Boulet, Institut Jean Lamour, Nancy, France, 5.-13. 12. 2013

STAFF

Researchers

1. Asst. Prof. Slavko Bernik
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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Marcela Achimovičová, Nina Daneu, A. Zorkovská, Martin Fabián, "The use of de-aggregating agents in ZnSe mechanochemical synthesis", *J. mater. sci., Mater. electron.*, vol. 24, no. 10, pp. 3686-3693, 2013.
2. Bojan Ambrožič, Sašo Šturm, Miha Jeršek, Breda Mirtič, "Structure of the chondrules and the chemical composition of olivine in meteorite Jesenice", *Geologija*, knj. 56, no. 1, pp. 19-28, 2013.
3. Sigrid Bernstorff, Václav Holý, Jan Endres, Václav Valeš, Jaroslav Sobota, Zdravko Siketić, Iva Bogdanović-Radović, Maja Buljan, Goran Dražić, "Co nanocrystals in amorphous multilayers - a structure study", *J. Appl. Crystallogr.*, vol. 46, no. 6, pp. 1711-1721, Dec. 2013.

4. Marko Bitenc, Barbara Horvat, Blaž Likozar, Goran Dražić, Zorica Crnjak Orel, "The impact of ZnO load, stability and morphology on the kinetics of the photocatalytic degradation of caffeine and resazurin", *Appl. catal., B Environ.*, vol. 136/137, pp. 202-209, 2013.
5. Maja Buljan *et al.* (13 authors), "Ge quantum dot lattices in Al₂O₃ multilayers", *J. nanopart. res.*, vol. 15, no. 3, pp. 1485-1-1484-13, 2013.
6. Maja Buljan *et al.* (11 authors), "Tuning the growth properties of Ge quantum dot lattices in amorphous oxides by matrix type", *J. Appl. Crystallogr.*, vol. 46, no. 5, pp. 1490-1500, 2013.
7. Maja Buljan, Nikola Radić, Iva Bogdanović-Radović, Zdravko Siketić, K. Salamon, M. Jerčinović, Mile Ivanda, Goran Dražić, Sigrid Bernstorff, "Influence of annealing conditions on the structural and photoluminescence properties of Ge quantum dot lattices in a continuous Ge + Al₂O₃ film", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, issue 8, pp. 1516-1521, 2013.
8. Jovana Ćirković, Katarina Vojisavljević, Maja Šćepanović, Aleksander Rečnik, Goran Branković, Zorica Branković, Tatjana Srećković, "Hydrothermally assisted complex polymerization method for barium strontium titanate powder synthesis", *J. sol-gel sci. technol.*, vol. 65, issue 2, pp. 121-129, 2013.
9. Nina Daneu, Nives Novak Gramc, Aleksander Rečnik, Marjeta Maček, Slavko Bernik, "Shock-sintering of low-voltage ZnO-based varistor ceramics with Bi₄Ti₃O₁₂ additions", *J. Eur. Ceram. Soc.*, vol. 33, issue 2, pp. 335-344, 2013.
10. Aleksandra Dapčević, Dejan Poleti, Ljiljana Karanović, Jelena Rogan, Goran Dražić, "Coexistence of several sillenite-like phases in pseudo-binary and pseudo-ternary systems based on Bi₂O₃", *Solid state sci.*, vol. 25, pp. 93-102, 2013.
11. Sandra Drev, Aleksander Rečnik, Nina Daneu, "Twinning and epitaxial growth of taaffeite-type modulated structures in BeO-doped MgAl₂O₄", *CrystEngComm (Camb., Online)*, vol. 15, issue 14, pp. 2640-2647, 2013.
12. Andreja Gajović, Jelena Vukajlović Pleština, Kristina Žagar, Milivoj Plodinec, Sašo Šturm, Miran Čeh, "Temperature-dependent Raman spectroscopy of BaTiO₃ nanorods synthesized by using a template-assisted solgel procedure", *J. Raman spectrosc.*, vol. 44, no. 3, pp. 412-420, 2013.
13. Davor Gracin, Zdravko Siketić, Krunoslav Juraić, Miran Čeh, "Analysis of amorphous-nanocrystalline silicon thin films by time-of-flight elastic recoil detection analysis and high-resolution electron microscopy", In: Proceedings of the NANOSMAT, 7th International Conference on Surfaces, Coatings and Nanostructured Materials, 18-21 September 2012, Prague, Czech Republic, *Appl. Surf. Sci.*, vol. 275, pp. 19-22, 2013.
14. Anton Gradišek, Dorte Ravnsbæk, Stanislav Vrtnik, Andraž Kocjan, Janez Lužnik, Tomaž Apih, Torben R. Jensen, Alexander V. Skripov, Janez Dolinšek, "NMR study of molecular dynamics in complex metal borohydride LiZn₂(BH₄)₅", *The journal of physical chemistry. C, Nanomaterials and interfaces*, vol. 117, no. 41, pp. 21139-21147, 2013.
15. Nejc Hodnik, Milena Zorko, Barbara Jozinović, Marjan Bele, Goran Dražić, Stanko Hočevar, Miran Gaberšek, "Severe accelerated degradation of PEMFC platinum catalyst: a thin film IL-SEM study", *Electrochem. commun.*, vol. 30, pp. 75-78, 2013.
16. Aljaž Iveković, Saša Novak, Goran Dražić, Darina Blagoeva, Sehila Gonzalez de Vicente, "Current status and prospects of SiC_f/SiC for fusion structural applications", *J. Eur. Ceram. Soc.*, vol. 33, no. 10, pp. 1577-1589, 2013.
17. S. Kahrman, S. Çetinkaya, Matejka Podlogar, Slavko Bernik, H. A. Çetinkaya, H. S. Güder, "Effects of the sulfurization temperature on sol gel-processed Cu₂ZnSnS₄ thin films", *Ceram. int.*, vol. 39, no. 8, pp. 9285-9292, 2013.
18. Danijela Klemenčič, Petra Muha, Wioleta Klepacka, Brigita Tomšič, Andrej Demšar, Arun P. Aneja, Kristina Žagar, Barbara Simončič, "Vpliv postopka priprave koloidnih raztopin srebra na lastnosti vlaken iz polimlečne kisline", *Tekstilec*, vol. 56, no. 4, pp. 302-211, 2013.
19. Ladislav Kosec, Štefan Šavli, Stjepan Kožuh, Tamara Holjevac-Grgurić, Aleš Nagode, Gorazd Kosec, Goran Dražić, Mirko Gojić, "Transformation of austenite during isothermal annealing at 600-90023C for heat resistant stainless steel", *J. alloys compd.*, vol. 567, pp. 59-64, avg. 2013.
20. Matic Krivec, Ricardo A. Segundo, Joaquim Luís Faria, Adrián M. T. Silva, Goran Dražić, "Low-temperature synthesis and characterization of rutile nanoparticles with amorphous surface layer for photocatalytic degradation of caffeine", *Appl. catal., B Environ.*, vol. 140-141, pp. 9-15, 2013.
21. Matic Krivec, Kristina Žagar, Luka Suhadolnik, Miran Čeh, Goran Dražić, "A highly efficient TiO₂-based microreactor for photocatalytic applications", *ACS appl. mater. interfaces*, vol. 5, issue 18, pp. 9088-9094, 2013.
22. Zorica Lazarević, Čedomir Jovalekić, A. Milutinović, Dušan Sekulić, Valentin Ivanovski, Aleksander Rečnik, Božidar Cekić, Nebojša Romčević, "Nanodimensional spinel NiFe₂O₄ and ZnFe₂O₄ ferrites prepared by soft mechanochemical synthesis", In: Proceedings of the International Symposium on Applications of Ferroelectrics: European Conference on the Applications of Polar Dielectrics; International Symposium Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials, 9-13 of July, 2012, Aveiro, Portugal, *J. Appl. Phys.*, vol. 113, no. 18, pp. 187221-1-187221-11, 2013.
23. Zorica Lazarević, Čedomir Jovalekić, Aleksander Rečnik, Valentin Ivanovski, Aleksandra Milutinović Živin, Maja J. Romčević, Miodrag B. Pavlović, Božidar Cekić, Nebojša Romčević, "Preparation and characterization of spinel nickel ferrite obtained by the soft mechanochemically assisted synthesis", *Mater. res. bull.*, vol. 48, issue 2, pp. 404-415, 2013.
24. Rita R. N. Marques, Marija J. Sampaio, Pedro M. Carrapiço, Cláudia G. Silva, Sergio Morales-Torres, Goran Dražić, Joaquim Luís Faria, Adrián M. T. Silva, "Photocatalytic degradation of caffeine: developing solutions for emerging pollutants", In: Proceedings of the SPEA 7, 7th European Meeting on Solar Chemistry and Photocatalysis: environmental Applications, 17-20 June 2012, Porto, Portugal, *Catal. Today*, vol. 209, pp. 108-115, 2013.
25. Lev Matoh, Irena Kozjek-Škofic, Miran Čeh, Nataša Bukovec, "A novel method for preparation of a platinum catalyst at low temperatures", *J. mater. chem. A*, vol. 1, no. 4, pp. 1065-1069, 2013.
26. Momir Milosavljević, Marko Obradović, Ana Grce, Davor Peruško, Dejan Pjević, Janez Kovač, Goran Dražić, Chris Jeynes, "High dose ion irradiation effects on immiscible AlN/TiN nano-scaled multilayers", In: Proceedings of the 6th International Conference on Technological Advances of Thin Films & Surface Coatings, July 14-17, 2012, Singapore, *Thin Solid Films*, vol. 544, pp. 562-566, 2013.
27. Momir Milosavljević, Dragan Toprek, Marko Obradović, Ana Grce, Davor Peruško, Goran Dražić, Janez Kovač, Kevin P. Homewood, "Ion irradiation induced solid-state amorphous reaction in Ni/Ti multilayers", *Appl. surf. sci.*, vol. 268, 8 pp.ustr. 516-523, 2013.
28. Peter Nadrah, Uroš Maver, Anita Jemec, Tatjana Tišler, Marjan Bele, Goran Dražić, Mojca Benčina, Albin Pintar, Odon Planinšek, Miran Gaberšek, "Hindered disulfide bonds to regulate release rate of model drug from mesoporous silica", *ACS appl. mater. interfaces*, vol. 5, issue 9, pp. 3908-3915, 2013.
29. Iztok Naglič, Kristina Žužek Rožman, Paul J. McGuinness, Luka Kelhar, Spomenka Kobe, Boštjan Markoli, "Production of Ni-Mn-Ga foam", *RMZ-mater. geoenviron.*, vol. 60, no. 3, pp. 191-196, 2013.
30. Saša Novak, Aljaž Iveković, "SiC-CNT composite prepared by electrophoretic Co-deposition and polymer infiltration and pyrolysis process", In: Proceedings of the 4th International Conference on Electrophoretic Deposition: Fundamentals and Applications, October 2-7, 2011, Puerto Vallarta, Mexico, *J. Phys. Chem. B*, vol. 117, no. 6, pp. 1680-1685, 2013.
31. Marko Obradović, Saša Novak, H. Jorg Meisel, A. Dinnyes, Nenad Filipović, "Finite element modeling of axonal elongation and use of stem cells", *Journal of the Serbian Society for Computational Mechanics*, vol. 7, no. 2, pp. 20-28, 2013.
32. Peter Panjan, Peter Gselman, Darja Kek-Merl, Miha Čekada, Matjaž Panjan, Goran Dražić, Tonica Bončina, Franc Zupanič, "Growth defect density in PVD hard coatings prepared by different deposition techniques", In: Proceedings of the 40th International Conference on Metallurgical Coatings and Thin Films, 29 April 3 - May 2013, San Diego, California, *Surf. Coat. Technol.*, vol. 237, pp. 349-356, 2013.
33. Jelena Pantić, Aleksandar Kremenović, Anja Došen, Marija Prekajski, Nadežda Stanković, Zvezdana Bašćarević, Branko Matović, "Influence of mechanical activation on sphenic based ceramic material synthesis", *Ceram. int.*, vol. 39, issue 1, pp. 483-488, 2013.
34. Davor Peruško, M. Čizmović, Suzana Petrović, Zdravko Siketić, Miodrag Mitrić, Primož Pelicon, Goran Dražić, Janez Kovač, Velimir Milinović, Momir Milosavljević, "Laser irradiation of nano-metric Al/Ti multilayers", *Laser phys.*, vol. 23, no. 3, pp. 036005-1-036005-7, 2013.
35. Milica Počuča, Zorica Marinković Stanojević, Zorica Branković, Patricia Cotić, Slavko Bernik, M. Sousa Góes, B. A. Marinković, José A. Varela, Goran Branković, "Mechanochemical synthesis of yttrium manganite", *J. alloys compd.*, vol. 552, 451-456, 2013.
36. Matejka Podlogar, Damjan Vengust, Jacob J. Richardson, Martin Strojnik, Matjaž Mazaj, Gregor Trefalt, Nina Daneu, Aleksander Rečnik, Slavko Bernik, "Parametric study of seed-layer formation for low-temperature hydrothermal growth of highly oriented ZnO films on glass substrates", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, issue 6, pp. 1083-1092, 2013.
37. Benjamin Podmiljšak, J. H. Kim, Paul J. McGuinness, Spomenka Kobe, "Influence of Ni on the magnetocaloric effect in Nanoperm-typesoft-magnetic amorphous alloys", *J. alloys compd.*, vol. 591, pp. 29-33, 2013.

38. Matej Pregelj, Peter Jeglič, Andrej Zorko, Oksana Zaharko, Tomaž Apih, Anton Gradišek, Matej Komelj, Helmut Berger, Denis Arčon, "Evolution of magnetic and crystal structures in the multiferroic $\text{FeTe}_2\text{O}_5\text{Br}$ ", *Phys. rev. B, Condens. matter mater. phys.*, vol. 87, no. 14, pp. 144408-1-144408-8, 2013.
39. Katja Rade, Anže Martinčič, Saša Novak, Spomenka Kobe, "Feasibility study of SiC-ceramics as a potential material for bone implants", *J. Mater. Sci.*, vol. 48, issue 15, pp. 5295-5301, 2013.
40. Nevenka Rajič, Nataša Zabukovec Logar, Aleksander Rečnik, Mohamad El-Roz, Frederic Thibault-Starzyk, Paul Sprenger, Lenka Hannevold, Anne Andersen, Michael Stöcker, "Hardwood lignin pyrolysis in the presence of nano-oxide particles embedded onto natural clinoptilolite", *Microporous and mesoporous materials*, vol. 176, pp. 162-167, 2013.
41. Aleksander Rečnik, Ilona Nyíró-Kósa, István Dódy, Mihály Pósfai, "Growth defects and epitaxy in Fe_3O_4 and $\gamma\text{-Fe}_2\text{O}_3$ nanocrystals", *CrystEngComm (Camb., Online)*, vol. 15, issue 37, pp. 7539-7547, 2013.
42. Zoran Samardžija, Kristina Žužek Rožman, Darja Pečko, Spomenka Kobe, "Compositional and microstructural analyses of Fe-Pd nanostructured thin films", *Mater. tehnol.*, vol. 47, no. 5, pp. 647-651, 2013.
43. David Sojer, Irena Škulj, Spomenka Kobe, Janez Kovač, Paul J. McGuinness, "Analysis of corrosion properties of melt spun Nd-Fe-B ribbons coated by alumina coatings", *Mater. tehnol.*, vol. 47, no. 2, pp. 223-228, mar.-apr. 2013.
44. Nikolaos Spyropoulos Antonakakis, Evangelia Sarantopoulou, Goran Dražič, Zoe Kollia, Dimitrios Christofilos, Gerasimos Kourouklis, Dimitrios Palles, Alciviadis-Constantinos Cefalas, "Charge transport mechanisms and memory effects in amorphous TaN_x thin films", *Nanoscale research letters*, vol. 8, pp. [1-18], Oct. 2013.
45. Sašo Šturm, Kristina Žužek Rožman, Boštjan Markoli, Nikolaos Spyropoulos Antonakakis, Evangelia Sarantopoulou, Zoe Kollia, Alciviadis-Constantinos Cefalas, Spomenka Kobe, "Pulsed-laser fabrication of gas-filled hollow CoPt nanospheres", *Acta mater.*, vol. 61, no. 61, pp. 7924-7930, 2013.
46. Janez Zavašnik, Aleksander Rečnik, "Electron microscopy study of CVT grown Fe-sulphides", *J. cryst. growth*, vol. 367, pp. 18-23, 2013.
47. Maciej Zubko, József Kusz, Albert Prodan, Sašo Šturm, Herman J. P. van Midden, J. Craig Bennett, Grzegorz Dubin, Erik Zupanič, Horst Böhm, "Structural phase transition and related electronic properties in quasi-one-dimensional $(\text{NbSe}_3)_{10/3}$ ", *Acta crystallogr., B Struct. sci.*, vol. 69, no. 3, pp. 229-237, 2013.
48. Kristina Žagar, Cristian Fàbrega, Francisco Hernandez-Ramirez, Joan Daniel Prades, Joan Ramón Morante, Aleksander Rečnik, Miran Čeh, "Insight into the structural, electrical and photoresponse properties of individual Fe: SrTiO₃ nanotubes", *Mater. chem. phys.*, vol. 141, issue 1, pp. 9-13, 2013.
- In: *MiMe - materials in medicine, 1st edition, October 8-11, Faenza, Italy: conference guide, final program and abstract book*, [S. l., s. n.], 2013, pp. 249.
6. Danijela Klemenčič, Barbara Simončič, Brigita Tomšič, Andrej Demšar, Franci Kovač, A. P. Aneja, Kristina Žagar, Peter Dušak, "Preparation of silver nanoparticles and their antimicrobial activity on cotton fabric", In: *Conference proceedings, 13th Autex Conference*, May 22-24, 2013, Dresden, Germany, Dresden, Technische Universität Dresden, ITM, 2013, 5 f.
7. Matic Krivec, Luka Suhadolnik, Kristina Žagar, Miran Čeh, Goran Dražič, "Photocatalytic water treatment with TiO₂: slurry reactor vs. microreactor", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference*, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 313-322.
8. Boštjan Markoli, Iztok Naglič, Kristina Žužek Rožman, Paul J. McGuinness, Spomenka Kobe, "Magnetic shape memory effect in Ni-based alloys", In: *Proceedings, 45th International October Conference on Mining and Metallurgy - IOC 2013*, Bor, Serbia, 16-19 October 2013, Nada Štrbac, ed., Dragana Živković, ed., Svetlana Nestorović, ed., Bor, Technical Faculty, 2013, pp. 616-619.
9. Polona Mrak, Nada Žnidaršič, Kristina Žagar, Miran Čeh, Jasna Štrus, "Cuticle formation during marsupial development of the crustacean Porcello scaber: imaging and analysis", In: *MC 2013: Microscopy Conference 2013, August 25-30, Regensburg, Germany*, [S. l., s. n.], 2013, pp. 345-346.
10. Rok Rudež, Slavko Bernik, "Studies of concentrated inks for the screen printing of thick-film varistors", In: *Proceedings, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems*, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 245-250.
11. Zoran Samardžija, Kristina Žužek Rožman, Darja Pečko, Spomenka Kobe, "Characterization of the morphology and chemical composition of FdxPd_{1-x} nanorods by advanced FEGSEM and low-voltage EDS analyses", In: *MC 2013: Microscopy Conference 2013, August 25-30, Regensburg, Germany*, [S. l., s. n.], 2013, pp. 670-671.
12. Sašo Šturm, "Correlated EDXS and EELS compositional analyses in Dy-doped Nd-Fe-B-based magnets", In: *MC 2013: Microscopy Conference 2013, August 25-30, Regensburg, Germany*, [S. l., s. n.], 2013, pp. 521-522.
13. Tea Toplišek, Medeja Gec, Aljaž Iveković, Saša Novak, Spomenka Kobe, Goran Dražič, "Analytical electron microscopy of W-core $\beta\text{-SiC}$ fibers for use in SiC in based composite material for fusion application", In: *Special issue of IUMAS-V & ALC'11, 5th International Union of Microbeam Analysis Societies, 8th International Symposium on Atomic Level Characterizations for New Materials and Devices'11, 22-27 May 2011, Seoul, Korea*, (Microscopy and microanalysis, vol. 19, suppl. S5, 2013), New York, Springer-Verlag, 2013, vol. 19, spec. issue S5, pp. 136-139, 2013.
14. Xiangkai Xiao, Lihong Chen, Guorong Li, Liaoying Zheng, Slavko Bernik, "The impact of new melting point MoO_3 sintering additives on zinc oxide varistor", In: *20th Chinese Varistors Society Annual Academic Conference, 12-15 November 2013, Shenzhen, China*, 20th Chinese Varistors Society Annual Academic Conference, 12-15 November 2013, Shenzhen, China, Danfeng Sun, ed., [S. l.], Chinese Electronics Sensor Technology Branch, 2013, pp. 39-42.
15. Kristina Žagar, Francisco Hernandez-Ramirez, Joan Daniel Prades, Joan Ramón Morante, Aleksander Rečnik, Sašo Šturm, Miran Čeh, "Insight into the structural and electrical properties of individual BaTiO_3 nanorods", In: *MC 2013: Microscopy Conference 2013, August 25-30, Regensburg, Germany*, [S. l., s. n.], 2013, pp. 403-404.

PUBLISHED CONFERENCE CONTRIBUTION

1. Anže Abram, Goran Dražič, "Hidrotermalna sinteza fotokatalitične prevleke iz TiO₂ na aluminiju", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference*, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 232-238.
2. Slavko Bernik, Marko Pribošek, "Construction and characteristics of a Z-meter setup for thermoelectric measurements of materials", In: *Proceedings, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems*, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 121-126.
3. M. Čizmović, Janez Kovač, Momir Milosavljević, Suzana Petrović, Goran Dražič, M. Mitrić, Marko Obradović, Peter Schaaf, Davor Peruško, "Intermixing in Al/Ti multilayer structures induced by nanosecond laser pulses", In: *Proceedings of the 3rd International Conference on the Physics of Optical Materials and Devices, 26 September 2012, Belgrade, Serbia*, (Physica scripta, Vol. T157, 2013), Stockholm, Royal Swedish Academy of Sciences, 2013, vol. 157, pp. 014008-1-014008-6, 2013.
4. Sandra Drev, Aleksander Rečnik, Nina Daneu, "Twinning and inclusions in chrysoberyl from Pratinhas, Brazil", In: *MC 2013: Microscopy Conference 2013, August 25-30, Regensburg, Germany*, [S. l., s. n.], 2013, pp. 375-376.
5. Ana Gantar, Lucília P. da Silva, Joaquim M. Oliveira, Alexandra P. Marques, Nataša Drnovšek, Vitor M. Correló, Rui L. Reis, Saša Novak, "Bioactive glass reinforcement of 3D gellan gum scaffolding material",

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. S. A. C. Carabineiro, B. F. Machando, Goran Dražič, Joaquim Luís Faria, José Luís Figueiredo, "Catalytic potential of gold nanoparticles supported over anatase and rutile TiO₂ for CO oxidation", In: *Nanotechnology. Vol. 3, Properties of nanomaterials*, Shismir Sinha, ed., [S. l.], Studium Press, 2013, pp. 125-140.
2. Marijan Gotič, Tanja Jurkin, Goran Dražič, "Hematite nanotubes and nanorings", In: *Hematite: sources, properties and applications*, (Geology and mineralogy research developments), Deniz Morel, ed., New York, Nova Science Publishers, Inc., [2013], pp. 85-108.

3. Sašo Šturm, Boštjan Jančar, "Microstructure characterization of advanced ceramics", In: *Advanced ceramics for dentistry*, Zhijian Shen, ed., Tomaž Kosmač, ed., Amsterdam ... [et al.], Elsevier, 2013, pp. 151-170.

(A1), European Patent Office, 29.5.2013; US2013190888 (A1), US Patent Office, 25.7.2013.

SCIENTIFIC MONOGRAPH

1. Aleksander Rečnik, *Minerals of the mercury ore deposit Idria*, Heidelberg [etc.], Springer, cop. 2013.
2. Aleksander Rečnik, *I minerali del giacimento di mercurio di Idrija*, Ljubljana, Institut "Jožef Stefan", [Salzhemmendorf], Bode, cop. 2013.

PATENT APPLICATION

1. Saša Novak, Nataša Drnovšek, Gregor Murn, *Implant Having a Multilayered Coating and a Process for Preparing Thereof*, EP2595669

MENTORING

1. Barbara Horvat, *Synthesis, growth, self-assembly and photocatalytic properties of TiO₂ nanoparticles prepared with a hydrothermal route*: doctoral dissertation, Ljubljana, 2013 (mentor Goran Dražič).
2. Aljaž Ivekovič, *Development of SiC-based composite material for fusion application*: doctoral dissertation, Ljubljana, 2013 (mentor Saša Novak Krmpotič).
3. Marko Soderžnik, *The development of an optimum core-shell microstructure for high-coercivity Nd-Fe-B magnets with minimum heavy-rare-earth content*: doctoral dissertation, Ljubljana, 2013 (mentor Paul McGuinness).

DEPARTMENT FOR MATERIALS SYNTHESIS

K-8

The research of the Department for Materials Synthesis is mainly related to the synthesis of various advanced materials, especially magnetic materials, semiconducting oxides, and optical materials. Special attention is given to nanostructured materials, such as ferrofluids, functionalized nanoparticles for use in biomedicine, multifunctional nanocomposites, magnetic coatings for use in the microwave frequency range, and fluorescent materials.

In 2013 our investigations have focused on several important materials, i.e., materials containing magnetic nanoparticles, multifunctional nanocomposites, fluorescent materials, and ferroelectric, semiconducting materials for the preparation of thermistors.

The research on magnetic nanoparticles has mainly looked at magnetic carriers for applications in magnetic separation in biotechnology, in environmental technologies, and in medicine. The magnetic separation is based on the selective bonding of targeted species, i.e., ions, molecules, cells, or microorganisms, onto the magnetic carriers followed with their separation from the mixture using an external magnetic field. Simple magnetic iron oxide is used as the material for the magnetic carriers, which have to be composed of magnetic nanoparticles that are small enough to be in the superparamagnetic state, i.e., below approximately 15 nm. Individual superparamagnetic nanoparticles are usually not efficient in magnetic separation, because of a too small magnetic force acting on them in a magnetic-field gradient, which is the result of their very small volume. In order to improve the ability of magnetic separation, the superparamagnetic nanoparticles have to be agglomerated into nanoclusters, optimally with size from 50 to 100 nm. The superparamagnetic nanoclusters were synthesized using the hetero-agglomeration (self-assembly) of the nanoparticles in the suspensions of superparamagnetic iron-oxide maghemite nanoparticles applying an attractive electrostatic force between nanoparticles with an opposite surface charge or the chemical reactions between surface molecules. For the synthesis of the nanoclusters, the maghemite nanoparticles were coated with a thin layer of silica and grafted by silane molecules with either terminal amino groups (for a positive surface charge in aqueous suspensions), or with terminal carboxyl groups (a negative surface charge). For an easier analysis, one type of the nanoparticles was changed with equally functionalized silica nanoparticles (Figure 1). The hetero-agglomeration of the two types of nanoparticles caused by the electrostatic interactions or by the chemical reactions between the surface amino groups and activated carboxyl groups has been systematically studied. The hetero-agglomeration using the chemical interactions between the nanoparticles resulting from direct reactions between the amino and carboxyl groups of the molecules at their surfaces appeared to be more efficient compared to hetero-agglomeration using electrostatic interactions. The kinetics of the hetero-agglomerates' formation in the suspension has been studied in cooperation with the Department for Complex Matter (F7).

Novel superparamagnetic nanoclusters with a size of approximately 60 nm were synthesized using the chemically-driven crosslinking of functionalized superparamagnetic nanoparticles. Their surface was then coated with a thin silica shell. The fluorescent molecules were incorporated into the silica shell for tracking of the nanoclusters with methods based on fluorescence microscopy. Special attention has been given to an adaptation of the nanoclusters' surface properties to the demands of specific applications. The nanoclusters' surface needs to be suitably functionalized with specific functional groups that enable further (bio)conjugations. The nanoclusters were functionalized either with organosilane molecules, which form covalent bonds with the silica shell, or using the layer-by-layer deposition of cationic and anionic polyelectrolytes. Nanoclusters functionalized with different molecules were investigated in the magnetic separation of heavy-metal ions from contaminated water. Magnetic nanoclusters could also be interesting in many other applications where a relatively large magnetic force acting on the nanocluster in a magnetic field gradient could be beneficially exploited. Magnetic drug delivery and cell-transfection (magnetofection) using magnetic nanoclusters are the most promising applications in the biomedical field.



Head:
Prof. Darko Makovec

The hetero-agglomeration of nanoparticles in their aqueous suspensions is based on electrostatic interactions between the nanoparticles displaying an opposite surface charge or based on chemical reactions between molecules on their surfaces.

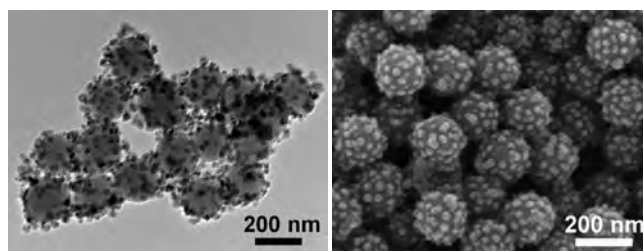


Figure 1: TEM image (left) and SEM image (right) of nanoclusters synthesized using the heteroagglomeration of iron-oxide maghemite nanoparticles and silica nanoparticles in the suspension.

We have also continued our research on magnetic nanoparticles for cancer treatment by magnetic hyperthermia. Magnetic hyperthermia is based on the heating ability of magnetic nanoparticles, localized in tumour tissue, when exposed to alternating magnetic fields. Depending on the magnetic properties of the magnetic nanoparticles the heating can be a consequence of the lag between the magnetization and the AC field (for superparamagnetic nanoparticles) or of the hysteresis losses (for ferrimagnetic nanoparticles). The magnetic iron oxide nanoparticles

Magnetic coupling in composite nanoparticles composed of a hard-magnetic hexaferrite core and a soft-magnetic maghemite shell has been analysed. The coupling results in an increase of the energy product $|\text{BH}|_{\text{max}}$ by more than 50 % compared to the $|\text{BH}|_{\text{max}}$ of the core nanoparticles.

are believed to be the most suitable magnetic nanoparticles for biomedical applications, because their use has been approved by the American Food and Drug Administration (FDA). In collaboration with the Powder Technology Laboratory, EPFL Switzerland we have developed a synthesis method that enables good control over the size of the nanoparticles. The nanoparticles were synthesized by a hydrothermal process in the presence of ricinoleic acid, which acts as a surfactant. The surfactant bonds to the nanoparticle surfaces and inhibits their growth. The influence of the synthesis temperature and the concentration of ricinoleic acid on the nanoparticle average size have been systematically studied. The nanoparticle average size was successfully

controlled at values ranging between 9 nm and 30 nm. While the nanoparticles smaller than ~14 nm exhibited superparamagnetic behaviour the larger nanoparticles demonstrated ferromagnetic behaviour. In collaboration with the School of Pharmaceuticals Sciences, University of Genève-University of Lausanne, Switzerland, we have studied the heating properties of the nanoparticles. The measurements showed that the optimal heating characteristics were exhibited by the ferrimagnetic nanoparticles. Additionally, the nanocomposites that contained the magnetic nanoparticles in a polymer matrix were prepared. Such nanocomposites are suitable for the fixation of vertebrae affected by cancer and enable additional treatment with magnetically induced hyperthermia.

A part of our research was also devoted to magnetic nanoparticles with an adaptable Curie temperature (T_c) for use in self-regulating magnetic hyperthermia. The T_c limits the temperature to which the nanoparticles are being heated in an external magnetic field, and thus an external temperature control is not required. In cooperation with the Faculty of Chemistry and Chemical Technology, University of Maribor, we have studied the synthesis and properties of the nanoparticles made of those magnetic materials, where the T_c can be tuned to the therapeutic values by adapting their composition. The main focus was on spinel ferrite $\text{Mg}(\text{Ti})\text{Fe}_2\text{O}_4$ and on different alloys from the systems Cu-Ni and Cr-Ni.

The synthesis of cobalt-ferrite nanoparticles (CoFe_2O_4) and their stable suspensions was also investigated. We focused on spinel ferrite nanoparticles in the size region from sizes where superparamagnetism dominates to the region where ferrimagnetism dominates the magnetic properties. For certain applications, colloidal suspensions

of ferrimagnetic nanoparticles in various carrier liquids are desired. The preparation of the suspensions and their colloidal and magnetic properties have been systematically studied. Ricinoleic acid was used as the surfactant for the nonpolar media and citric acid for the aqueous media. The CoFe_2O_4 nanoparticles were synthesized by the co-precipitation of $\text{Fe}^{3+}/\text{Co}^{2+}$ ions from the aqueous solution. The addition of a strong base to an aqueous solution of cations results in the precipitation of an amorphous Co-deficient phase and $\text{Co}(\text{OH})_2$. The precipitates react to form very small CoFe_2O_4 nanoparticles, which at a later stage grow through the Ostwald ripening process, reaching a final size of ~14 nm. The synthesized nanoparticles displayed relatively high values of saturation magnetization and coercivity. The adsorption of the citrate anion on the nanoparticle surfaces enabled the preparation of the aqueous colloidal suspensions. The adsorption of ricinoleic acid on the nanoparticle surfaces enabled the preparation of a colloidal suspension in toluene. However, the ricinoleic acid was not efficient in preventing the agglomeration of nanoparticles larger than ~15 nm in toluene. The markedly

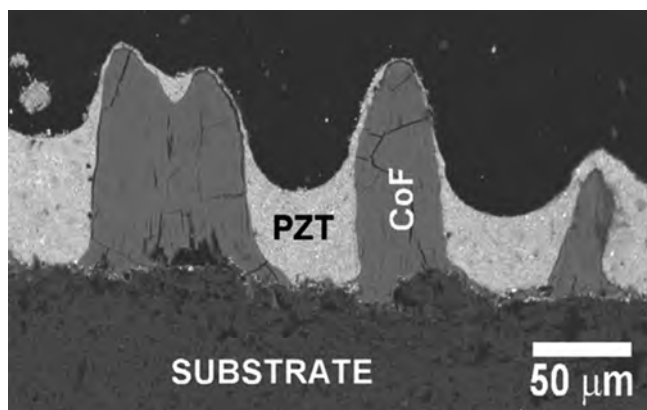


Figure 2: Magneto-electric composite synthesized by the assembly of CoFe_2O_4 nanoparticles and $\text{Pb}(\text{Zr,Ti})\text{O}_3$

different colloidal behaviour was qualitatively described by the total interaction energy between the two nanoparticles. The citrate-anion-adsorbed nanoparticles in the aqueous media are negatively charged and therefore repulsive. The interaction between the ricinoleic-acid-adsorbed nanoparticles is attractive. The attraction in toluene is larger than the thermal energy for nanoparticles larger than ~15 nm. Both suspensions displayed superparamagnetic behaviour, despite the ferrimagnetic nature of the dispersed nanoparticles.

We also cooperated in nanotoxicology research with the Biotechnical Faculty, University of Ljubljana, where we provided our expertise in the synthesis, functionalization and characterization of nanoparticles.

CoFe_2O_4 shows magnetic properties that are not typical for spinel ferrites, i.e., a high magnetic anisotropy, which results in high coercivity and magnetostriction. It shows the largest magnetostriction among oxide materials and

is therefore suitable for applications in multifunctional composites like: magneto-electrics, in which magnetic and ferroelectric properties are mechanically coupled. The properties of such composites depend on the basic properties of the constituent phases and on the specific phase distribution in the material. We prepared columnar structures with a magnetically directed assembly of CoFe_2O_4 nanoparticles from the suspensions. The effect of the colloidal properties on the morphology of the columns has been systematically studied. The results showed that the density distribution of the columns on a substrate, their height and roughness depend on the nanoparticle concentration in the suspension, the wetting angle and the evaporation rate of the solvent. Thus, various 3D structures can be assembled from the CoFe_2O_4 nanoparticles by tuning the magnetic field distribution using a template. The anisotropic CoFe_2O_4 3D structures can be used as a basis for magneto-electric composites with a 1-3-type structure. Their preparation using the electrophoretic deposition of $\text{Pb}(\text{Zr},\text{Ti})\text{O}_3$ on top of the CoFe_2O_4 columns has been studied in cooperation with Electronic Ceramics Department (K5) (Figure 2). We also prepared $\text{CoFe}_2\text{O}_4/\text{Pb}(\text{Zr},\text{Ti})\text{O}_3$ composite ceramics by co-sintering of the constituent powders at 950°C . The magnetic properties of these ceramic composites were greatly affected by an electric field.

A large part of our research was devoted to the synthesis and detailed characterisation of composite nanoparticles synthesized using a coating of thin shells of magnetic iron oxide onto different core nanoparticles using simple precipitation from aqueous solutions. By coating a shell of soft-magnetic spinel iron oxide maghemite ($\text{g-Fe}_2\text{O}_3$) onto hard-magnetic barium-hexaferrite ($\text{BaFe}_{12}\text{O}_{19}$) platelet cores the “sandwich”-type composite nanoparticles were synthesized. Such sandwich nanoparticles are composed of the hexaferrite core in between the two spinel layers. The spinel layers grow epitaxially on the hexaferrite core with spinel {111} planes parallel to the hexaferrite basal {0001} planes. Magnetic coupling between the two components has been analysed. The magnetic coupling results in a large increase in the energy product $|\text{BH}|_{\text{max}}$ by more than 50 % compared to the $|\text{BH}|_{\text{max}}$ of the core nanoparticles. When the ultrafine hexaferrite core nanoparticles, with a size below 10 nm, were coated the two components chemically reacted. The homogeneous product nanoparticles are formed as the result of the chemical reaction. The product nanoparticles differ in composition and in structure from any known compound in the BaO-FeO_x system. The temperature stability of the product nanoparticles has been studied using high-resolution electron microscopy (HREM) and magnetic measurements.

The magnetic shell was also coated onto the core nanoparticles of other functional materials including photocatalytic anatase nanoparticles (TiO_2). On the other hand, the possibility of coating shells made of other magnetic spinels, especially of hard-magnetic cobalt ferrite, has been investigated.

We continued our research on the synthesis of nanocomposite particles used for the decomposition of organic pollutants in water. The nanocomposite particles are composed of photocatalytic anatase (TiO_2) nanoparticles coated onto agglomerates of superparamagnetic maghemite (Fe_2O_3) nanoparticles. For the photocatalytic purification, the particles are dispersed in polluted water. The surface anatase layer provides a high photocatalytic activity, while the superparamagnetic cores enable the separation of the particles from the suspension after the purification and their re-use. The research was mainly oriented to mechanisms enabling an increase in the photocatalytic activity of the materials applying electronic interactions at the interface between the two semiconducting components, the anatase (band gap $E_g \sim 3.2$ eV) and the maghemite ($E_g \sim 2.3$ eV). It appeared that the photocatalytic activity of the anatase nanoparticles is significantly increased when they are in contact with the maghemite nanoparticles. The photocatalytic activity of the nanocomposite can be additionally increased using doping of the anatase with aliovalent dopants, such as Fe^{3+} and W^{6+} .

The studies in the field of magnetic materials for telecommunications were focused on the development of ceramic films for micro- and mm-wave applications. We broadened our research on the preparation of magnetically oriented $\text{BaFe}_{12}\text{O}_{19}$ thick films in a magnetic field on the comparative study of the effect of the shape anisotropy versus magnetic interparticle interaction. We were able to achieve a magnetic orientation higher than 80% only by the deposition of the $\text{BaFe}_{12}\text{O}_{19}$ nanoplates on a substrate without any external field. This kind of assembly during the drying of the suspensions was attributed to the magnetic interparticle interaction. Such films are suitable for self-biased magnetic devices, including nonreciprocal microwave devices.

The studies in hexaferrite materials were also focused on the hydrothermal and coprecipitation synthesis of $\text{BaFe}_{12}\text{O}_{19}$ nanoplates and the effect of the

We showed a significant inverse magneto-electric effect in $\text{CoFe}_2\text{O}_4/\text{Pb}(\text{Zr},\text{Ti})\text{O}_3$ ceramic composites.

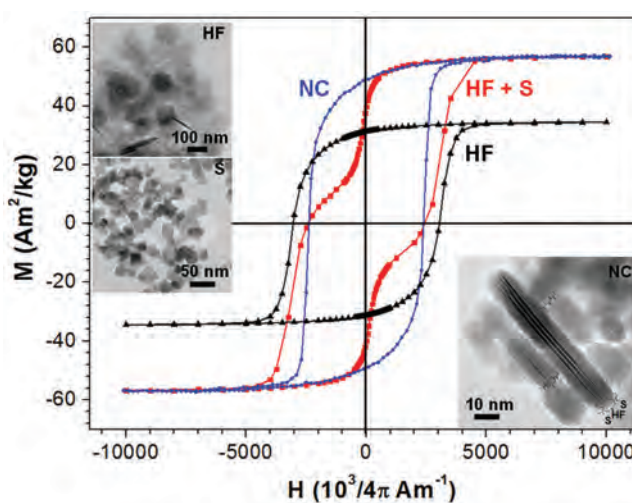


Figure 3: An in-plane magnetic hysteresis of the composite nanoparticles (NC) composed of a hard-magnetic hexaferrite core in between the two soft-magnetic spinel layers is compared with the hysteresis of hexaferrite core nanoparticles (HF) and the hysteresis of hexaferrite and spinel (S) nanoparticles. The comparison suggests magnetic coupling between the components in the composite.

chemical substitution of Fe^{3+} with Sc^{3+} on the size of the nanoplates. The size distribution can be effectively narrowed with the Sc^{3+} regardless of the synthesis conditions. At the same time, the magnetic properties of the nanoplates are improved significantly. Magnetic liquid crystals were developed from these nanoplates in cooperation with the Department of Condensed Matter (F7). The Sc-based nanoplates were also incorporated into a polymer matrix and

We showed that nanoplates with applicable magnetic properties can be synthesized by a partial chemical substitution of Fe^{3+} with Sc^{3+} in $\text{BaFe}_{12}\text{O}_{19}$ and that these nanoplates are suitable for the preparation of new magneto-optic materials: magnetic liquid crystals and transparent magnetic polymer composites.

we prepared a transparent magnetic polymer composite in cooperation with the Faculty of Chemistry and Chemical Technology of University of Maribor. Both types of new composites exhibit applicable magneto-optic properties.

We have started with a study of fluorescent optical materials. We studied the synthesis of fluoride nanoparticles doped with lanthanides and their nanocomposites with a silica shell. The main focus was oriented toward the control of the particle size, the suspension stability and the chemical stability of fluorides in an aqueous environment. The specified particle size is required for the incorporation of the nanoparticles into the optical-fibre

technology. These studies are conducted in the frame of a common project with a company Optacore: "Optical fibres doped with fluorescent nanoparticles". Fluorescent fluoride nanoparticles were suggested as alternative bio-markers. They have to show a chemical stability in aqueous environment and they are to be used in bio-medicine. However, we showed that the fluoride nanoparticles were not stable in water suspensions and they require special care before their application in bio-medicine.

The research in the field of semiconducting ceramics has been focused on the effect of the positive temperature coefficient of resistivity (PTCR). A BaTiO_3 -based composite composed of undoped semiconducting BaTiO_3 grains and highly resistive BaTiO_3 grains was prepared. We showed that such a composite, which mimic a conventional BaTiO_3 thermistor, exhibits a significant anomaly in electrical resistivity due to the disconnection of the network of semiconducting BaTiO_3 grains at the Curie temperature. The anomaly in resistivity was of three orders of magnitude. The result of this investigation will change the basic picture of the functioning of this ceramic, which is in its mature age of exploitation.

In the field of high-temperature thermistors (PTC resistors) we continued to investigate the processes of their formation in ferroelectric ceramics from the systems BaTiO_3 - $\text{Na}_{0.5}\text{Bi}_{0.5}\text{TiO}_3$. The PTC resistors displaying a Curie temperature of 180 °C and low room-temperature resistivity were developed. Unlike the conventional high-temperature PTCR materials available on the market the developed material contains no poisonous lead.

Some outstanding publications in the past year

1. Kralj, S., Rojnik, M., Romih, R., Jagodič, M., Kos, J., Makovec, D.: Effect of surface charge on the cellular uptake of fluorescent magnetic nanoparticles. *J. nanopart. res.*, 2012, vol. 14, no. 10, 1151-1-1151-14
2. Mertelj, A., Lisjak, D., Drogenik, M., Čopič, M.: Ferromagnetism in suspensions of magnetic platelets in liquid crystal. *Nature*, ISSN 0028-0836, 2013, vol. 504, no. 7479, 237-241

INTERNATIONAL PROJECT

1. COST IC1208; Integrating Devices and Materials: A Challenge for New Instrumentation in ICT
COST Office
Prof. Darko Makovec

RESEARCH PROGRAM

1. Advanced Inorganic Magnetic and Semiconducting Materials
Prof. Darko Makovec

NEW CONTRACTS

1. Optical Fibers Doped with Fluorescent Nanoparticles
Optacore, d. o. o.
Asst. Prof. Darja Lisjak
2. Research and Development of PTCR-effect Semiconducting Ceramics without Environmentally Harmful Lead Oxide
Stelem, d. o. o., Žužemberk
Dr. Igor Zajc
3. Development of Analytical Methods and Characterisation of Pharmaceutical Form Containing Iron-Oxide Nanoparticles
Lek, d. d.
Prof. Darko Makovec

VISITORS FROM ABROAD

1. Dr. Marin Tadić, Vinca Institute, Condensed Matter Physics Laboratory, University of Belgrade, Beograd, Serbia, 6. 8.-30. 10. 2013
2. Bernardo Maestro Maria Beatriz, Instituto de Ceramica y Vidrio (CSIC), Madrid, Spain, 4. 11.-4. 12. 2013
3. Dr. Lionel Maurizi, LTP EPFL, Switzerland, 1.-7. 12. 2013
4. Debora Bonvin, LTP EPFL, Switzerland, 1.-7. 12. 2013

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9. Olivija Plohl, B. Sc.
10. *Dr. Darinka Primc, left 01.04.13*
11. Klementina Pušnik, B. Sc.

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12. Bernarda Anželak, B. Sc.

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Branka Babić-Stojić, Vojka Jokanović, D. Milivojević, Zvonko Jagličić, Darko Makovec, N. Jović, Milena Marinović Cincović, "Magnetic properties and magnetic relaxation in a suspension of CoFe_2O_4 nanoparticles", *J. appl. phys.*, vol. 113, no. 23, pp. 234311-1-234311-4, 2013.
2. Branka Babić-Stojić, Vukoman Jokanović, D. Milivojević, Zvonko Jagličić, Darko Makovec, Nataša Jović, Milena Marinović Cincović, "Magnetic and structural studies of CoFe_2O_4 nanoparticles suspended in an organic liquid", *J. Nanomaterials (Online)*, vol. 2013, article ID 741036, pp. 1-9, 2013.
3. Irena Ban, Janja Stergar, Mihael Drogenik, Gregor Ferik, Darko Makovec, "Synthesis of chromium-nickel nanoparticles prepared by a microemulsion method and mechanical milling", *Acta chim. slov.*, vol. 60, no. 4, pp. 750-755, 2013.
4. Boštjan Denac, Matjaž Kristl, Sašo Gyergyek, Mihael Drogenik, "Preparation and characterization of ternary cadmium chalcogenides", *Chalcogenide Lett.*, vol. 10, no. 3, pp. 87-98, March 2013.
5. Saim Emin, Mattia Fanetti, Fatwa F. Abdi Abdi, Darja Lisjak, Matjaž Valant, R. van de Krol, Bernard Dam, "Photoelectrochemical properties of cadmium chalcogenide-sensitized textured porous zinc oxide plate electrodes", *ACS appl. mater. interfaces*, vol. 5, iss. 3, pp. 1113-1121, 2013.
6. Saim Emin, Darja Lisjak, Michael W. Pitcher, Matjaž Valant, "Structural and morphological transformations of textural porous zinc sulfide microspheres", *Microporous and mesoporous materials*, vol. 165, pp. 185-192, jan. 2013.
7. A. Gianoncelli, P. Marmorato, J. Ponti, L. Pascolo, Burkhard Kaulich, C. Uboldi, F. Rossi, Darko Makovec, Maya Petrova Kiskinova, G. Ceccone, "Interaction of magnetic nanoparticles with U87MG cells studied by synchrotron radiation X-ray fluorescence techniques", In: Proceedings of the European Conference on X-Ray Spectrometry, 18-22 June 2012, Vienna, Austria, *X-Ray Spectrom.*, vol. 42, no. 4, pp. 316-320, 2013.
8. Samo Hudoklin, Daša Zupančič, Darko Makovec, Mateja Erdani-Kreft, Rok Romih, "Gold nanoparticles as physiological markers of urine internalization into urothelial cells in vivo", *International journal of nanomedicine*, vol. 8, no. 1, pp. 3945-3953, 2013.
9. N. Jović, Nikola Cvjetičanin, Branka Babić-Stojić, Darko Makovec, Vojka Jokanović, "Synthesis of hematite and iron oxyhydroxide nanocrystals by precipitation of Fe_{3+} ions inside oleic acid micelles", *Ceram. int.*, vol. 39, no. 5, pp. 5659-5665, 2013.
10. Petra Kocbek, Slavko Kralj, Mateja Erdani-Kreft, Julijana Kristl, "Targeting intracellular compartments by magnetic polymeric nanoparticles", In: Emerging Nanopharmaceuticals for Non-parenteral Application Routes, *Eur. J. Pharm. Sci.*, vol. 50, issue 1, pp. 130-138, 2013.
11. Slavko Kralj, Matija Rojnik, Janko Kos, Darko Makovec, "Targeting EGFR-overexpressed A431 cells with EGF-labeled silica-coated magnetic nanoparticles", *J. nanopart. res.*, vol. 15, no. 5, pp. 1666-1-1666-11, 2013.
12. Matjaž Kristl, Irena Ban, Sašo Gyergyek, "Preparation of nanosized copper and cadmium chalcogenides by mechanochemical synthesis", *Mater. manuf. process.*, vol. 28, iss. 9, pp. 1009-1013, 2013.
13. Matjaž Kristl, Nuša Hojnik, Sašo Gyergyek, Mihael Drogenik, "Sonochemical preparation of copper sulfides with different phases in aqueous solutions", *Mater. res. bull.*, vol. 48, iss. 3, pp. 1184-1188, Mar. 2013.
14. Darja Lisjak, Simona Ovtar, "The alignment of barium ferrite nanoparticles from their suspensions in electric and magnetic fields", In: Proceedings of the 4th International Conference on Electrophoretic Deposition: Fundamentals and Applications, October 2-7, 2011, Puerto Vallarta, Mexico, *J. Phys. Chem. B*, vol. 117, no. 6, pp. 1644-1650, 2013.
15. Darko Makovec, Tanja Goršak, Klementina Zupan, Darja Lisjak, "Hydrothermal synthesis of $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ dendrites", *J. cryst. growth*, vol. 375, no. 1, pp. 78-83, 2013.
16. Alenka Mertelj, Darja Lisjak, Mihael Drogenik, Martin Čopič, "Ferromagnetism in suspensions of magnetic platelets in liquid crystal", *Nature (Lond.)*, vol. 504, no. 7479, pp. 237-241, 2013.
17. Tina Mesarič, Lokesh Baweja, Barbara Drašler, Damjana Drobne, Darko Makovec, Peter Dušak, Alok Dhawan, Kristina Sepčič, "Effects of surface curvature and surface characteristics of carbon-based nanomaterials on the adsorption and activity of acetylcholinesterase", *Carbon (N. Y.)*, vol. 62, pp. 222-232, 2013.
18. Ana Mraković, Jovan Blanuša, Darinka Primc, Marija Perović, Zvonko Jagličić, Vladan Kusigerski, Vojislav Spasojević, "Modified self-propagating high-temperature synthesis of nanosized $\text{La}_{0.7}\text{Ca}_{0.3}\text{MnO}_3$ ", *Ceram. int.*, vol. 39, issue 4, pp. 3771-3777, 2013.
19. Sara Novak, Damjana Drobne, Miha Golobčič, Jernej Zupanc, Tea Romih, Alessandra Gianoncelli, Maya Petrova Kiskinova, Burkhard Kaulich, Primož Pelicon, Primož Vaupetič, Luka Jeromel, Nina Ogrinc, Darko Makovec, "Cellular internalisation of dissolved cobalt ions from ingested CoFe_2O_4 nanoparticles: in vivo experimental evidence", *Environ. sci. technol.*, vol. 47, no. 10, pp. 5400-5408, 2013.
20. Brigita Rožič, Marko Jagodič, Sašo Gyergyek, Zvonko Jagličić, Samo Kralj, Vassilios Tzitzios, George Cordoyiannis, Zdravko Kutnjak, "Indirect magnetoelectric coupling in mixtures of magnetite and ferroelectric liquid crystal", In: Proceedings of the ISAF ECAPD PMF 2012, International Symposium on Applications of Ferroelectrics; European Conference on the Applications of Polar Dielectrics; International Symposium Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials, 9-13 of July, 2012, Aveiro, Portugal, *Ferroelectrics*, vol. 448, no. 1, pp. 12-16, 2013.
21. Janja Stergar, Gregor Ferik, Irena Ban, Mihael Drogenik, Anton Hamler, Marko Jagodič, Darko Makovec, "The synthesis and characterization of copper-nickel alloy nanoparticles with a therapeutic Curie point using the microemulsion method", *J. alloys compd.*, vol. 576, pp. 220-226, 5. nov. 2013.
22. Metka Šimundić, Barbara Drašler, Vid Šuštar, Jernej Zupanc, Roman Štukelj, Darko Makovec, Deniz Erdoğmus, Henry Hägerstrand, Damjana Drobne, Veronika Kralj-Iglič, "Effect of engineered TiO_2 and ZnO nanoparticles on erythrocytes, platelet-rich plasma and giant unilamellar phospholipid vesicles", *BMC veterinary research*, vol. 9, no. 7, pp. 1-13, 2013.
23. Matjaž Valant, Iztok Arčon, Iuliia Mikulska, Darja Lisjak, "Cation order-disorder transition in Fe-doped $6\text{H} - \text{BaTiO}_3$ for dilute room-temperature ferromagnetism", *Chem. mater.*, vol. 25, no. 17, pp. 3544-3550, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Peter Dušak, Slavko Kralj, Darko Makovec, "Synthesis of superparamagnetic clusters as a carrier for wine fining agents", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 257-267.
2. Petra Jenuš, Darja Lisjak, Danjela Kuščer, Darko Makovec, Mihael Drogenik, "Co-sintering of magnetoelectric composites of Co-ferrite and selected ferroelectrics", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 278-287.
3. Danijela Klemenčič, Barbara Simončič, Brigita Tomšič, Andrej Demšar, Franci Kovač, A. P. Aneja, Kristina Žagar, Peter Dušak, "Preparation of silver nanoparticles and their antimicrobial activity on cotton fabric", In: *Conference proceedings*, 13th Autex Conference, May 22-24, 2013, Dresden, Germany, Dresden, Technische Universität Dresden, ITM, 2013, 5 f.
4. Olivija Plohl, Darja Lisjak, Darko Makovec, Mihael Drogenik, "Synthesis of LAF_3 nanoparticles", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 331-338.
5. Klementina Pušnik, Mihael Drogenik, Darko Makovec, "Preparation of stable colloidal aqueous suspensions of magnetic iron-oxide nanoparticles using aspartic acid as surfactant", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 349-356.

MENTORING

1. Darinka Primc, *Heterogeneous nucleation of iron oxides ($\gamma\text{Fe}_2\text{O}_3$) in colloidal systems*: doctoral dissertation, Ljubljana, 2013 (mentor Darja Lisjak).
2. Aljaž Selišnik, *Photocatalytic properties of magnetically-retractable nanocomposites containing iron oxide and titania*: doctoral dissertation, Ljubljana, 2013 (mentor Darko Makovec).

DEPARTMENT FOR ADVANCED MATERIALS

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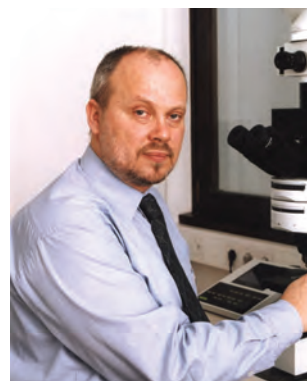
The main activities of the department encompass basic and applied research within the fields of energy materials, biomaterials and electronic materials. Among the important objectives are the development of new, efficient oxides for high-temperature thermoelectric energy conversion, materials with improved antibacterial and photocatalytic effects and the development of thin films and nanostructured powders of functional oxides for various electronic applications.

Thermoelectric oxides

Continued research on thermoelectric layered cobaltates $\text{Ca}_{3-x}\text{Na}_x\text{Co}_4\text{O}_9$ showed that intergrown structures exhibit a Seebeck coefficient higher than both the end members, Na_xCoO_2 and $\text{Ca}_3\text{Co}_4\text{O}_9$. With an increase in x the electrical conductivity can be tailored from semiconducting to metallic behaviour, which enables control of the power factor of the material. The highest measured power factor was at compositions with $x \sim 1$, which also exhibit environmental stability as opposed to pure Na_xCoO_2 . In the scope of the industrial project with Epcos, a part of TDK-EPC company, we performed a study of the development of intergrown structures and their influence on the texturing and, consequently, the electrical conductivity. We found that the formation of an intergrown structure prior to the sintering stage crucially influences the microstructure and, consequently, the electrical conductivity. We have also found that intergrown structures are stable in an air atmosphere up to 930°C , above which a reversible loss of oxygen takes place, resulting in the formation of a secondary phase CoO . In an inert atmosphere the reversible decomposition takes place already at temperatures below 500°C . The findings indicate that based on coherently intergrown structures $\text{Ca}_{3-x}\text{Na}_x\text{Co}_4\text{O}_9$ high-temperature p-type thermoelectric materials with an operating range up to $\sim 900^\circ\text{C}$ can be synthesized. At 700°C ceramics with the nominal composition $\text{Ca}_{2.2}\text{Na}_{0.8}\text{Co}_4\text{O}_9$ exhibit a figure of merit $zT \sim 0.3$. The results obtained so far also indicate that a further improvement of the conversion efficiency is possible by reducing thermal conductivity and so controlling the atmosphere during processing and thus influencing the formation of nano-inclusions within the coherently intergrown matrix.

Antibacterial and photocatalytic materials

Nanocomposite materials based on TiO_2 and Pt particles were prepared via two syntheses, i.e., hydrothermal synthesis and sonochemical synthesis, followed by thermal treatment in a reducing atmosphere at 400°C for 3 h. The hydrothermally synthesized TiO_2/Pt consisted of TiO_2 (average particles size 16 nm) in the anatase and the rutile crystal modification. TiO_2/Pt prepared by the sonochemical synthesis crystallized as the TiO_2 (average particle size 9 nm) anatase and brookite. The hydrothermal synthesis enabled the formation of two types of Pt particles: the Pt particles (12-17 nm) that were attached on the TiO_2 surface and the Pt particles that existed as an isolated phase (up to 45 nm). In the case of the sonochemical synthesis the Pt particles (up to 5 nm) formed a composite with the TiO_2 particles. The XPS surface analysis of the prepared TiO_2/Pt revealed that the formed Pt existed as Pt^0 and Pt^{2+} . The presence of the free hydroxyl groups was identified utilizing the FTIR spectroscopy. The free surface hydroxyl groups were detected only in the case of the hydrothermally synthesized TiO_2/Pt . The photocatalytic activity was



Head:
Prof. Danilo Suvorov

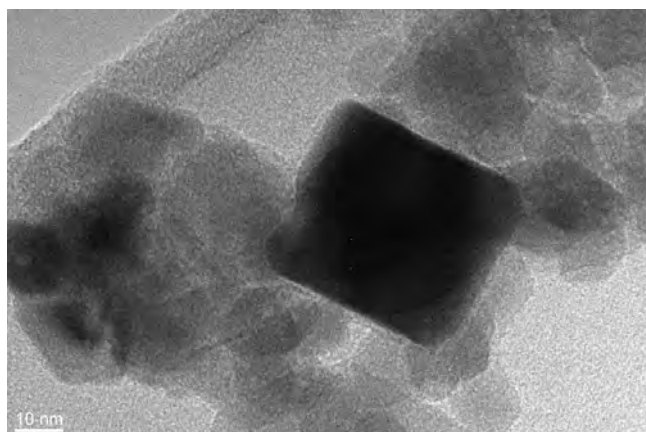


Figure 1: Hydrothermally synthesized TiO_2/Pt .

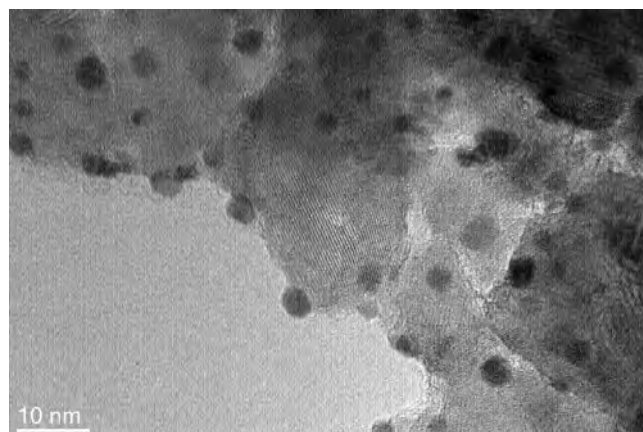


Figure 2: Sonochemically synthesized TiO_2/Pt .

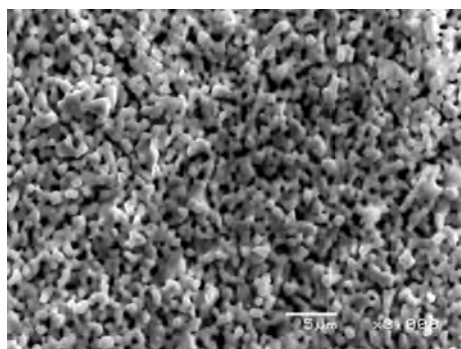


Figure 3: SEM image of BSO thin films deposited on Si/SiO₂/TiO₂/Pt substrate annealed at 700°C/1h.

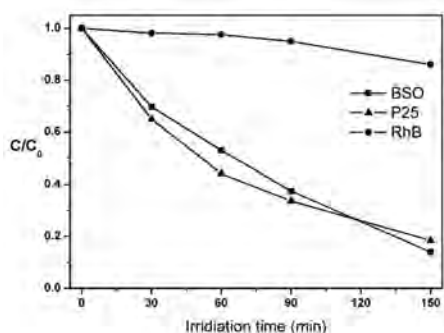


Figure 4: The degradation rate of the RhB solution under UV irradiation with the photocatalyst BSO film and P25 film

determined by monitoring the degradation of the aqueous solution of the azo dye methylene blue under UV and Vis irradiation. The measurements revealed that the UV photocatalytic activity of the hydrothermally synthesized TiO₂/Pt was 16-times higher than the activity of the sonochemically synthesized TiO₂/Pt. Under Vis irradiation the photocatalytic performance of the hydrothermally synthesized TiO₂/Pt exceeded the activity of the sonochemically prepared TiO₂/Pt by 5-times. The higher photocatalytic efficiency of the hydrothermally synthesized TiO₂/Pt was ascribed to the presence of the free surface hydroxyl groups. Such hydroxyl groups form with the photogenerated holes from the TiO₂ valence band strong hydroxyl radicals, which degraded the organic compounds adsorbed on the surface of the TiO₂.

Photocatalytic films based on the sillenite compound Bi₁₂SiO₂₀ (BSO) were prepared using the polymerizable complex method. The obtained BSO films had a porous microstructure with an average size of the grains equal to 1 μm. Its photocatalytic activity was evaluated with the degradation of the aqueous organic pollutant Rhodamine B under UV-light irradiation. The Bi₁₂SiO₂₀ films showed comparable photocatalytic performance in the degradation of the RhB solution under UV-light irradiation as the reference Degussa P25 film. Namely, both photocatalytic films BSO and P25 degraded over 82% of the RhB solution within the irradiation time of 150 min.

In 2013 we also focused on the syntheses of new antibacterial materials that include a gallium component. This should increase the efficiency of the functionalized gold nanoparticles on hydroxyapatite, which have recently been developed at this department, but avoid the increase of their harmfulness towards eukaryotic (human) cells. Using a sonochemical method we successfully prepared nanocomposites of gold nanoparticles, functionalized with amino acids, and hydroxyapatite with Ga(III) ions, most probably in its interstitials. All the nanoparticles in the composite are spherical, of very similar size (with a diameter of approx. 5 nm with histidine, approx. 10 nm with arginine and approx. 20 nm with glycine) and well separated on the hydroxyapatite nanorods. We also managed to obtain a composite of hydroxyapatite with spherical gallium nanoparticles, covered with GaOOH. A gold nanoshell with different amino acids attached is being added to these nanoparticles, in order to obtain functionalized core-shell nanodevices for targeted drug delivery of an antibacterial (gallium) core.

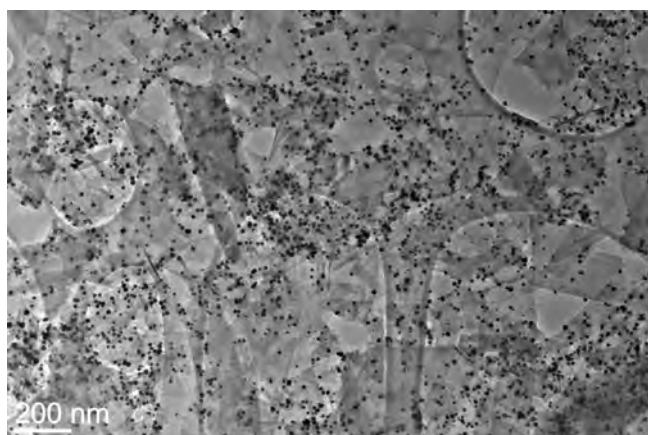


Figure 5: Nanocomposite of arginine-functionalized Au nanoparticles and Ga(III)-containing hydroxyapatite under a transmission electron microscope.

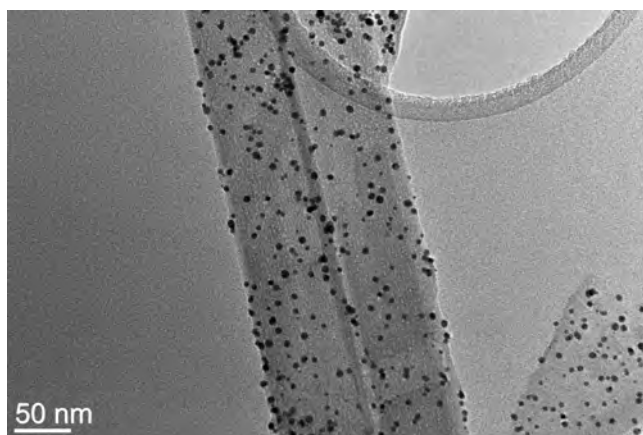


Figure 6: TEM picture of histidine-functionalized Au nanoparticles on hydroxyapatite nanorods with incorporated Ga(III) ions

Functional oxides for electronic applications

In the field of the investigation of phase relations in ternary oxide systems where new compounds and/or solid solutions are stable and exhibit pronounced electric properties, we determined phase relations in the ternary systems La₂O₃-TiO₂-CaO at 1400°C in previous research. This year we continued with investigations and we determined the crystallographic structure of the solid solution CaTiO₃-Ca₃La₄Ti₃O₁₅, which is stable along the whole tie line. We described a transition from one crystal structure into another and determined the microstructural and dielectric properties of these ceramics. For the synthesis of the single-phase ceramics a modified Pechini method was used.

We have also investigated ceramics based on the compound CaCu₃Ti₄O₁₂, which exhibit interesting dielectric properties and ceramics based on the solid solution CaCu₃Ti₄O₁₂-CaCu₃Ru₄O₁₂.

The research of BaTiO₃ particle formation was focused on (i) the topotactic transformation of various titanate precursors into BaTiO₃, (ii) the characterization of tetragonal BaTiO₃ particles, prepared under moderate hydrothermal conditions, (iii) the sintering of variously shaped BaTiO₃ particles and a determination of the dielectric properties. The aim of the first part was to explore possibilities for the preparation of defined shaped BaTiO₃ particles by preserving the shape of the titanate precursor. This kind of transformation is possible in liquid phase (hydrothermal and molten salt synthesis) under conditions that favour the epitaxial growth of BaTiO₃ on a titanate precursor. These conditions include a low lattice mismatch and a low density of surface defects. The comparison of the BaTiO₃ lattice parameters with those of the titanate precursors (Na₂Ti₃O₇ (NT) belts, K₂Ti₆O₁₃ (KT) wires, K_{1.33}Li_{1.33}Ti_{3.33}O₈ (KLT) plates) showed a mismatch greater than 4%. Epitaxial growth could occur, when the high strains are relieved by the formation of dislocations and grain boundaries. Our investigations revealed that the topochemical transformation of the titanate precursor into BaTiO₃ was better approached by the NT belts than by the KLT plates and KT wires. The morphology of the BaTiO₃ particles formed from the last precursor at low temperature (80-100°C) was found to be very similar to that obtained with the NT belts. The differences appeared at T ≥ 150°C, where BaTiO₃ with a considerably higher degree of tetragonality was formed from KT compared to that from the other precursors. Raman spectroscopy, which gave information about the local structure, showed that the asymmetry within [TiO₆] the octahedra was present already in BaTiO₃, prepared at 100°C. According to the result of this technique, BaTiO₃ with a high degree of tetragonality formed from KT at 150 ≤ T ≤ 240°C. The differences in tetragonality for BaTiO₃ formed at different high-temperature (150 ≤ T ≤ 240°C) conditions could be better detected by XRD and DSC, because they gave information about long-range order. In XRD pattern, the tetragonality is evident from the splitting of the (200) diffraction line, while DSC gave the enthalpy of tetragonal to cubic phase transition. We found that tetragonality increased with an increase of the temperature and synthesis time. When the NaOH content exceeded the concentration needed for BaTiO₃ formation, the tetragonality decreased with an increase of the NaOH content.

The sintering studies of variously shaped (star- and square-like) cubic BaTiO₃ particles revealed that particle shape had an important influence on the grain growth and phase transformation. The sintering of square-like particles led to tetragonal ferroelectric and coarse grained (2-10 μm) BaTiO₃ ceramics, while star-like particles preserved the cubic crystal structure without a significant increase in the grain size (1 μm). High relative densities of 98% were achieved by two-step sintering, which is regarded as a promising method for controlling the grain growth. Based on this fact we assume that dielectric, ferroelectric and piezoelectric properties of BaTiO₃ ceramics could be tailored by the selection of the particle shape and the proper sintering conditions.

We have investigated the synthesis of Ag(Nb_xTa_{1-x})O₃ (x = 0.2-1) ceramics by a solid-state reaction method. Pure-phase ceramics with a relative density higher than 96% can be obtained, except for x = 0.2. As x decreases from 1, the dielectric constant at 2.9-4.4 GHz first increases from 222, reaches the maximum value of 491 for x = 0.65, and then decreases to 206 for x = 0.2. While the Q×f value increases monotonically from 72 GHz for x = 1 to 1.550 GHz for x = 0.2, although the ceramic with x = 0.2 is relatively porous and not single phase. The Ag(Nb_xTa_{1-x})O₃ (x = 0.5-1) ceramics show interesting tunable dielectric properties. When x = 1, unique “W”-shaped dependences of dielectric constant and dielectric loss on DC bias are observed, indicating the coexistence of ferroelectricity and anti-ferroelectricity. Similar results are observed for x = 0.8 and 0.65, while only anti-ferroelectricity is indicated for x = 0.5. The anti-ferroelectricity can be observed based on a tunability measurement with the maximum DC of 125 kV/cm or even lower. However, much higher electric field of 175 kV/cm is needed for observing an anti-ferroelectric-like hysteresis loop. It is indicated that the tunability measurement is a more sensitive tool than the hysteresis loop for determining the anti-ferroelectricity.

Ag(Nb_{0.5}Ta_{0.5})O₃ thin films have also been deposited on (0001) Al₂O₃ single-crystal substrates by pulsed laser deposition with a fluence of 1.5 J/cm² and an oxygen pressure of 0.1 mbar, and they are characterized by XRD and RHEED. When the target-to-substrate distance is 55 mm, the repetition rate is 5Hz and the deposition time is 1 hour, polycrystalline Ag(Nb_{0.5}Ta_{0.5})O₃ primary phase is indicated from XRD for the deposition temperatures of 550-625°C. However, a small concentration of secondary phase can also be

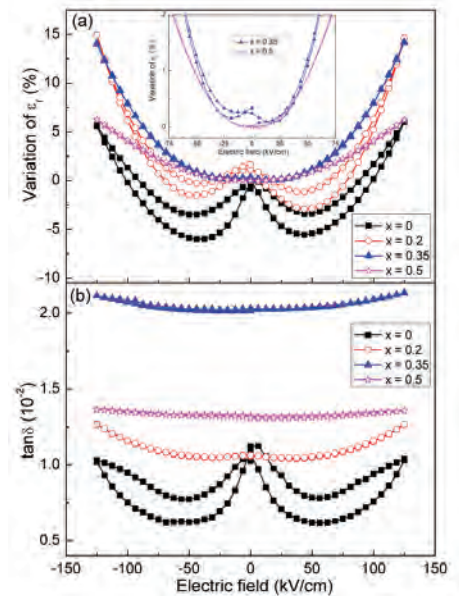


Figure 7: Tunable dielectric properties for Ag(Nb_xTa_{1-x})O₃ (x = 0.5-1) ceramics with “W”-shaped dependences of dielectric constant and dielectric loss on DC bias, indicating the coexistence of ferroelectricity and anti-ferroelectricity.

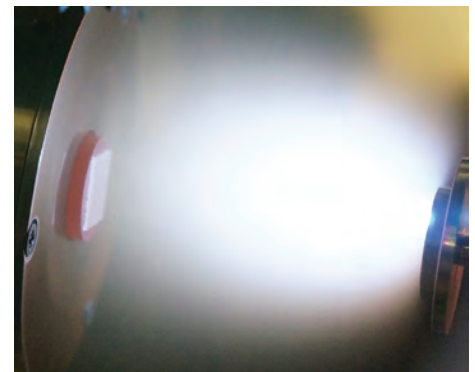


Figure 8: Plume created during laser ablation of Ag(Nb_{0.5}Ta_{0.5})O₃ ceramic target at 1.5 J/cm² laser energy and 0.1 mbar oxygen partial pressure in pulsed laser deposition system.

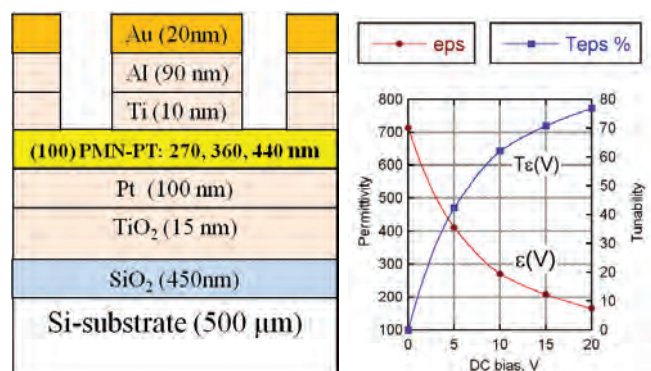


Figure 9: Cross-sectional view of the test resonators (a) and DC bias dependences of permittivity ($\epsilon(V)$) and relative tunability of permittivity ($T\epsilon(V)$), measured at 3 GHz, of a test structure with the 440-nm-thick PMN-PT film (b).

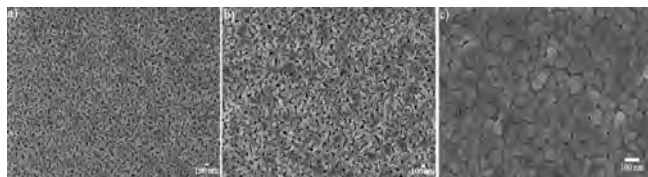


Figure 10: Microstructural development of PMN-PT thin films pyrolysed at temperature a) 200°C, b) 300°C in c) 430°C and annealed at 650°C/20 min.

In the scope of the Center of Excellence in Nanoscience and Nanotechnology we installed the Emyrean X-ray diffractometer at the Advanced Materials Department, which is utilized mainly for the detailed structural characterization of single-crystal thin films. The delivered system enables the study of the epitaxial layers in terms of reciprocal space-map measurements and a determination of epitaxial relationship with respect to the substrate, while the reflectivity measurements provide us information about the thickness, surface/interface roughness and density of single or multilayered structures on a substrate. The above-mentioned applications of the system are enabled by a sample stage with five computer-controlled and programmable axes and very powerful 2D area detector, capable of measuring in the 0D mode (standard point detector), 1D mode (fast linear detector) and 2D mode (area detector). In addition to a structural characterization of thin films, standard powder-diffraction measurements can also be performed, optionally with a diffracted beam monochromator for sample fluorescence removal. Furthermore, the system is equipped with high/low-temperature sample stages, which make it possible to measure samples over a broad temperature range from -261°C to 1200°C and in different gas atmospheres.



Figure 11: Emyrean X-ray diffraction system

observed in the patterns. When the target-substrate distance increases to 60 mm, a pure-phase $\text{Ag}(\text{Nb}_{0.5}\text{Ta}_{0.5})\text{O}_3$ thin film is formed with the thickness of 150 nm, which nevertheless should be doubled for measuring the microwave dielectric properties. When the deposition time increases to 2 hours, a small concentration of $\text{Ag}(\text{Nb}_{0.5}\text{Ta}_{0.5})\text{O}_{21}$ secondary phase appears due to the decomposition of $\text{Ag}(\text{Nb}_{0.5}\text{Ta}_{0.5})\text{O}_3$ after long-time deposition. In the final part of the work, the repetition rate increases to 10 Hz and the deposition time is set at 1 hour to reduce the decomposition of $\text{Ag}(\text{Nb}_{0.5}\text{Ta}_{0.5})\text{O}_3$. In this way, a pure-phase polycrystalline $\text{Ag}(\text{Nb}_{0.5}\text{Ta}_{0.5})\text{O}_3$ thin film with a thickness of 300 nm is obtained.

In the scope of NA FERBIO project we investigated the synthesis of PMN-PT thin films. In short, we systematically varied the conditions of the reagents in order to determine the influence of the coordination chemistry on the formation of the perovskite phase. Results revealed that the major contribution to the formation of single-phase perovskite PMN-PT thin films comes from the coordination of the Pb reagent. A pyrochlore-free PMN-PT film with (100) orientation was formed when the steric hindrance of the Pb precursor was increased by using polyvinylpyrrolidone (PVP). The (111) orientated PMN-PT thin films were prepared using sol-gel-derived TiO_2 as a nucleation layer. Our research was further focused on the influence of the pyrolysis treatment on the phase formation and microstructural development of PMN-PT thin films. The XRD results showed that a different pyrolysis treatment has no influence on the phase formation of thin films. In contrast, the microstructural development of the PMN-PT thin films strongly depends on the used pyrolysis temperature.

Based on PMN-PT films with (100) orientation FBAR devices were subsequently fabricated and tested. Films were deposited on platinized silicon substrates. More than 4% tuning of resonance frequency under DC field less than 15 V/ μm was demonstrated. In comparison with the $\text{Ba}_x\text{Sr}_{1-x}\text{TiO}_3$ based FBARs, this tunability was achieved at 2-3 times lower applied DC field. The other advantage of PMN-PT is the high electromechanical coupling coefficient that allows for development of wide-band tunable filters. Even though FBARs with this performance may be used in microwave circuits, the achieved tunability is not as high as we would anticipate from the large electrostriction coefficient of PMN-PT reported in the literature. In these experiments the lower electrostriction coefficient and lower tunability are due to the lower density of the PMN-PT films, which is the subject of forthcoming studies. An additional reduction of the tunability is due to large negative nonlinear electrostriction coefficient.

In addition, a part of our activities, in collaboration with an industrial partner, were focused on the development of aluminum foams. For such foams TiH_2 is used as a foaming agent. As an alternative forming agent we proposed in the past the application of dolomite. A drawback of the dolomite is its high decomposition temperature, which is above 820°C. In order to decrease its decomposition temperature we mechanically and chemically treated the dolomite and such products start to decompose at 400°C.

Within the cooperation with industrial partner Knauf Insulation d.o.o., the research work on the joint project was focused on the morphology and chemical composition of mineral fibres and their composites, crystallization and melting behaviour, aging process, determination of specific heat and thermal stability of mineral wools.

Organization of Conferences, Congresses and Meetings

1. Workshop on MATERA ERA-NET project "Novel inorganic inks for hybrid printed electronic demonstrators", Ljubljana, 16. 10. - 17. 10.2013.

- Materials Science & Technology 2013 Conference and Exhibition, Montreal, Canada, 27. 10. – 31. 10. 2013 (co-organizers).
- 21st Conference on Materials and Technologies, Portorož, 13. 11. – 15. 11. 2013 (co-organizers).
- Institute of Science and Technology for Ceramics, Faenza, Italy and Institut “Jožef Stefan” Workshop on Materials, Ljubljana, 11. 12. – 12. 12. 2013.



Figure 12: New laboratory for antibacterial materials analysis

Awards and Appointments

- Aničič Nemanja: Award of the Henkel Slovenia Foundation for B. Sc. Thesis, Faculty of Chemistry and Chemical Engineering, University of Maribor, Maribor, “Application of the population balance model for the prediction of concentrated emulsion droplet size distribution”.

Patent granted

- Marija Vukomanović, Srečo D. Škapin, Danilo Suvorov, Composites materials based on ceramic phase and metal with functionalized surface as environmentally-friendly materials with antibacterial activity, a process for preparing and use thereof, SI24094 (A), Urad RS za intelektualno lastnino, 31.12.2013.

We established a new laboratory for the analysis of antibacterial materials, where we will be able to grow bacterial and mammalian cells and examine their survival after being exposed to the prepared materials as well as their interactions with these materials.

INTERNATIONAL PROJECTS

- Thermoelectric Oxide Materials
EPCOS OHG Ceramic Components Division
Prof. Danilo Suvorov
- Microwave Tunable Materials, Composites and Devices
NATO - North Atlantic Treaty Organisation
Asst. Prof. Boštjan Jančar
- The Synthesis of Dielectric Materials by Chemical Solution Deposition and Characterization of their Dielectric Properties
Slovenian Research Agency
Prof. Danilo Suvorov
- Nanostructural Designing of Multifunctional and Sintered Electrical and Biological Functionally Graded Materials
Slovenian Research Agency
Asst. Prof. Srečo Davor Škapin
- Multifunctional Ferroelectric Materials based on Ag(Nb,Ta)O₃
Slovenian Research Agency
Prof. Danilo Suvorov

R&D GRANTS AND CONTRACTS

- Nanoengineering of Self-Assembled Materials
Prof. Danilo Suvorov
- New Materials for Power Conversion: Oxide Semiconductor Thermoelectrics
- Prof. Danilo Suvorov
- INNOINKS: Novel Inorganic Inks for Hybrid Printed Electronic Demonstrators
Prof. Danilo Suvorov
- NAFERBIO: Nanostructured Ferroelectric Films for Biosensor
- Prof. Danilo Suvorov

NEW CONTRACTS

- Development and Characterisation of Mineral Wool Fibres
Knauf Insulation, d. o. o., Škofja Loka
Prof. Danilo Suvorov
- New Materials for Energy Conversion: Oxide Semiconducting Thermoelectrics
Gorenje Household Appliances, d. d.
Prof. Danilo Suvorov

RESEARCH PROGRAM

- Contemporary Inorganic Materials and Nanotechnologies
Prof. Danilo Suvorov

VISITORS FROM ABROAD

- Hermann Gruenbichler, B. Sc., Dr. Manfred Schweinzer, Dr. Yongli Wang, TDK EPCOS, Deutschlandsberg, Austria, 6. 3. 2013.
- Dr. Markus Mente, Gorazd Šebenik, B. Sc., Borut Vežočanik, B. Sc., Knauf Insulation, Škofja Loka, 9. 5. 2013.
- Prof. Dr. Dragoljub Uskoković, Institut of Technical sciences of the Serbian Academy of Sciences and Arts, Belgrade, Serbia, 16. 7. – 17. 7. 2013.
- Prof. Dr. Ivan Sondi, Faculty of mining, geology and petroleum engineering, University of Zagreb, Zagreb, Croatia, 9. 4. 2013.
- Dr. Smilja Marković, Institut of Technical sciences of the Serbian Academy of Sciences and Arts, Belgrade, Serbia, 7. 6. – 19. 6. 2013.
- Dr. Jyoti Prosad Guha, Missouri University of Science and Technology, Rolla, USA, 10. 6. – 14. 8. 2013.
- Dr. Smilja Marković, Institut of Technical sciences of the Serbian Academy of Sciences and Arts, Belgrade, Serbia, 5. 8. – 14. 8. 2013.
- Prof. Dr. Suk-Joong L. Kang, Korea Advanced Institute of Science and Technology, Daejeon, South Korea, 28. 8. – 30. 8. 2013.
- Dr. Hiroyuki Enomoto, Dr. Kesaku Sonoda, Research Laboratories of NOF Corporation, Tsukuba, Japan, 16. 10. – 17. 10. 2013.
- Prof. Dr. Heli Jantunen, Dr. Jari Juuti, Dr. Mikko Nelo, Dr. Tuomo Sipponkoski, University of Oulu, Oulu, Finland, 16. 10. – 17. 10. 2013.
- Prof. Dr. Malgorzata Jakubowska, Dr. Marcin Sloma, Institute of Electronic Materials Technology, Warsaw, Poland, 16. 10. – 17. 10. 2013.
- Dr. Carmen Galassi, Piezoelectric Materials Research Group, Institute of Science and Technology for Ceramics, Faenza, Italy, 11. 12. – 12. 12. 2013.
- Dr. Michele Iafisco, Bioceramics Research Group, Institute of Science and Technology for Ceramics, Faenza, Italy, 11. 12. – 12. 12. 2013.
- Dr. Elisa Mercadelli, Dr. Alessandra Sanson, Materials Research Group, Institute of Science and Technology for Ceramics, Faenza, Italy, 11. 12. – 12. 12. 2013.
- Dr. Damir Dominko, Dr. Damir Staresinić, Institute of Physics, Zagreb, Croatia, 19. 12. 2013.
- Dr. Maja Dekić, Amra Salčinović, Faculty of natural sciences and mathematics, University of Sarajevo, Sarajevo, Bosnia and Herzegovina, 19. 12. 2013.

Visiting researchers

- Dr. Ismael Fabregas, Centro de Investigaciones en Sólidos, CITEFA, Buenos Aires, Argentina, 1. 1. 2013 – 31. 8. 2013.
- Dr. Zoran Jovanović, Faculty of Physical Chemistry, University of Belgrade, Belgrade, Serbia, 1. 1. 2013 – 31. 12. 2013.
- Dr. Lei Li, Zhejiang University, Hangzhou, China, 1. 1. 2013 – 31. 12. 2013

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4. Dr. Matjaž Spreitzer
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6. Asst. Prof. Srečo Davor Škapin

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10. Dr. Marija Vukomanović

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22. Silvo Zupančič

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Gabriela Ambrožič, Jernej Šribar, Srečo D. Škapin, Majda Žigon, Zorica Crnjak Orel, "An antibacterial macroporous polyurethane hybrid material with a high content of zinc ions: a template to uniform ZnO nanoparticles", *Mater. res. bull.*, vol. 48, no. 4, pp. 1428-1434, 2013.
2. In-Sun Cho, Chi Hwan Lee, Yunzhe Feng, Manca Logar, Pratap M. Rao, Lili Cai, Dong Rip Kim, Robert Sinclair, X. Zheng, "Codoping titanium dioxide nanowires with tungsten and carbon for enhanced photoelectrochemical performance", *Nature communications*, vol. 4, no. 3, pp. 1723-1-1723-8, 2013.
3. Nina Daneu, Nives Novak Gramc, Aleksander Rečnik, Marjeta Maček, Slavko Bernik, "Shock-sintering of low-voltage ZnO-based varistor ceramics with Bi₄Ti₃O₁₂ additions", *J. Eur. Ceram. Soc.*, vol. 33, issue 2, pp. 335-344, 2013.
4. Vilma Ducman, Vladimira Petrovič, Srečo D. Škapin, "Photo-catalytic efficiency of laboratory made and commercially available ceramic building products", *Ceram. int.*, vol. 39, issue 3, pp. 2981-2987, apr. 2013.
5. Helena Gradišar, Sabina Božič, Tibor Doles, Damjan Vengust, Iva Hafner Bratkovič, Alenka Mertelj, Ben Webb, Andrej Šali, Sandi Klavžar, Roman Jerala, "Design of a single-chain polypeptide tetrahedron assembled from coiled-coil segments", *Nature chemical biology*, vol. 9, issue 6, pp. 362-366, 2013.
6. Sonja Jovanović, Matjaž Spreitzer, Mojca Otoničar, Jae-Ho Jeon, Danilo Suvorov, "pH control of magnetic properties in precipitation-hydrothermal-derived CoFe₂O₄", *J. alloys compd.*, vol. 589, pp. 271-277, 2013.
7. Zoran Jovanović, Igor Pašti, Ana M. Kalijadis, Sonja Jovanović, Zoran V. Laušević, "Platinum-mediated healing of defective graphene produced by irradiating glassy carbon with a hydrogen ion-beam", *Mater. chem. phys.*, vol. 141, no. 1, pp. 27-34, 2013.
8. Dragana Jugović, Miodrag Mitrić, Miloš Milović, Bojan Jokić, Marija Vukomanović, Danilo Suvorov, Dragan Uskoković, "Properties of quenched LiFePO₄/C powder obtained via cellulose matrix-assisted method", *Powder technol.*, vol. 246, pp. 539-544, 2013.
9. Varužan Kevorkijan, Srečo D. Škapin, Uroš Kovačec, "The nondestructive determination of the aluminum content in pressed skulls of aluminum dross", *JOM (1989)*, vol. 65, iss. 2, pp. 284-293, Feb. 2013.
10. Gi-Yeop Kim, Myong-Ho Kim, Danilo Suvorov, Si-Young Choi, "Microstructural development of cobalt ferrite ceramics and its influence on magnetic properties", *Met. Mater. Int.*, vol. 19, no. 6, pp. 1209-1213, 2013.
11. Andrej Kovič, Damjan Vengust, Mojca Vilfan, Aleš Mrzel, "Controlled self-decoration of Mo₆S₈I₂ (8.2 ≤ y + z ≤ 10) nanowires and their transformation to MoS₂ nanotubes with gold nanoparticles", *J. nanopart. res.*, vol. 15, no. 7, pp. 1791-1-1791-13, 2013.
12. Špela Kunej, Asja Veber, Danilo Suvorov, "Electrical characterization of sol-gel-derived (1-x)NBT-x NTa (0.05 < x < 0.3) thin films", *Ceram. int.*, vol. 39, no. 5, pp. 5991-5995, 2013.
13. Špela Kunej, Asja Veber, Danilo Suvorov, "Sol-gel synthesis and characterization of Na_{0.5}Bi_{0.5}TiO₃ - NaTaO₃ thin films", *J. Am. Ceram. Soc.*, vol. 96, no. 2, pp. 442-446, 2013.
14. Mario Kurtjak, Tomaž Urbič, "Water in the presence of inert Lennard-Jones obstacles", *Mol. Phys.*, pp. 1-17.
15. Marjeta Maček, Ines Bračko, Bojan Budič, Danilo Suvorov, "The morphology control of BaTiO₃ particles synthesized in water and a water/ethanol solvent", *J. Am. Ceram. Soc.*, vol. 96, no. 11, pp. 3401-3409, 2013.
16. Marjan Marinšek, Martin Šala, Boštjan Jančar, "A study towards superior carbon nanotubes-supported Pd-based catalysts for formic acid electro-oxidation: preparation, properties and characterisation", *J. power sources*, vol. 235, no. 1, pp. 111-116, 2013.
17. Mojca Otoničar, Srečo D. Škapin, Boštjan Jančar, Danilo Suvorov, "Structural diversity of the (Na_{1-x}K_x)_{0.5}Bi_{0.5}TiO₃ perovskite at the morphotropic phase boundary", *J. appl. phys.*, vol. 113, no. 2, pp. 024106-1-024106-11, 2013.
18. Matejka Podlogar, Damjan Vengust, Jacob J. Richardson, Martin Strojnik, Matjaž Mazaj, Gregor Trefalt, Nina Daneu, Aleksander Rečnik, Slavko Bernik, "Parametric study of seed-layer formation for low-temperature hydrothermal growth of highly oriented ZnO films on glass substrates", *Phys. status solidi, A Appl. mater. sci.*, vol. 210, issue 6, pp. 1083-1092, 2013.
19. Maja Remškar, Ivan Iskra, Janez Jelenc, Srečo D. Škapin, Bojana Višić, Ana Varlec, Andrej Kržan, "A novel structure of polyvinylidene fluoride (PVDF) stabilized by MoS₂ nanotubes", *Soft matter*, vol. 9, no. 36, pp. 8647-8653, 2013.
20. Matjaž Spreitzer, Ricardo Juan Egoavil Escobar, Jo Verbeeck, Dave H. A. Blank, Guus Rijnders, "Pulsed laser deposition of SrTiO₃ on a H-terminated Si substrate", *J. mater. chem. C*, vol. 1, issue 34, pp. 5216-5222, 2013.
21. Zoran Stojanović, Mojca Otoničar, Jongwook Lee, Magdalena Stevanović, Mintai P. Hwang, Kwan Hyi Lee, Jonghoon Choi, Dragan Uskoković, "The solvothermal synthesis of magnetic iron oxide nanocrystals and the preparation of hybrid poly(l-lactide)/polyethyleneimine magnetic particles", *Colloids surf., B Biointerfaces*, vol. 109, pp. 236-243, 2013.
22. Tina Šetinc, Matjaž Spreitzer, Špela Kunej, Janez Kovač, Danilo Suvorov, "Temperature stable dielectric behavior of SolGel derived compositionally graded SrTiO₃/Na_{0.5}Bi_{0.5}TiO₃/SrTiO₃ thin films", *J. Am. Ceram. Soc.*, vol. 96, issue 11, pp. 3511-3517, 2013.
23. Tina Šetinc, Matjaž Spreitzer, Damjan Vengust, Ivan Jerman, Danilo Suvorov, "Inherent defects in sol-precipitation/hydrothermally derived SrTiO₃ nanopowders", *Ceram. int.*, vol. 39, issue 6, pp. 6727-6734, 2013.
24. Vuk Uskoković, Charles Hoover, Marija Vukomanović, Dragan Uskoković, Tejal A. Desai, "Osteogenic and antimicrobial nanoparticulate calcium phosphate and poly-(d,l-lactide-co-glycolide) powders for the treatment of osteomyelitis", *Mater. sci. eng., C, Biomim. mater., sens. syst.*, vol. 33, issue 6, pp. 3362-3373, 2013.
25. Takane Usui, Christine A. Donnelly, Manca Logar, Robert Sinclair, Joop Schoonman, Fritz B. Prinz, "Approaching the limits of dielectric

- breakdown for SiO₂ films deposited by plasma-enhanced atomic layer deposition", *Acta mater.*, vol. 61, issue 20, pp. 7660-7670, 2013.
- Asja Veber, Fabijan Dilber, Špela Kunej, "Modeling the electrode geometry of co-planar capacitors for the microwave dielectric characterization of ceramic thin films", *J. appl. phys.*, vol. 114, no. 22, pp. 224107-1- 224107-10, 2013.
 - Asja Veber, Špela Kunej, Danilo Suvorov, "Dielectric properties of sol-gel-derived Bi₁₂SiO₂₀ thin films", *J. Am. Ceram. Soc.*, vol. 96, no. 1, pp. 157-160, 2013.
 - Asja Veber, Špela Kunej, Danilo Suvorov, "The influence of the precursor on the formation of Bi₂O₃ polymorphs in CSD-derived thin films: Asja Veber, Špela Kunej and Danilo Suvorov", *J. Am. Ceram. Soc.*, vol. 96, no. 3, pp. 704-709, 2013.
 - Damjan Vengust, Boštjan Jančar, Andreja Šestan, Maja Ponikvar-Svet, Bojan Budič, Danilo Suvorov, "Chemical decomposition as a likely source of ambient and thermal instabilities of layered sodium cobaltate", *Chem. mater.*, vol. 25, no. 23, pp. 4791-4797, 2013.
 - Milica Vučinić-Vasić *et al.* (10 authors), "Thermal evolution of cation distribution/crystallite size and their correlation with the magnetic state of Yb-substituted zinc ferrite nanoparticles", *The journal of physical chemistry. C, Nanomaterials and interfaces*, vol. 117, no. 23, pp. 12358-12365, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

- Si-Young Choi, J. B. Lim, Y. Ikuhara, Danilo Suvorov, Jae-Ho Jeon, "Direct observation of cationic ordering in double perovskite Sr₂FeReO₆ crystals", In: *Special issue of IUMAS-V & ALC'11, 5th International Union of Microbeam Analysis Societies, 8th International Symposium on Atomic Level Characterizations for New Materials and Devices'11, 22-27 May 2011, Seoul, Korea*, (Microscopy and microanalysis, vol. 19, suppl. S5, 2013), New York, Springer-Verlag, 2013, vol. 19, spec. issue S5, pp. 25-28, 2013.
- Sonja Jovanović, Matjaž Spreitzer, Mojca Otoničar, Danilo Suvorov, "The influence of oleic acid on the morphology and magnetic properties of CoFe₂O₄ nanoparticles", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 288-295.*
- Marjeta Maček, Ni Qin, Danilo Suvorov, "Correlating the crystal structure and the phase transitions with the dielectric properties of K_xBa_{1-x}Ga_{2-x}Ge_{2+x}O₈ solid solutions", In: *Processing and properties of advanced ceramics and composites V*, (Ceramic transactions, vol. 240), Narottam P. Bansal, ed., [S. l.], Wiley, 2013, vol. 240, pp. 321-329, 2013.

- Smilja Marković, Miodrag Lukić, Čedomir Jovalekić, Srečo D. Škapin, Danilo Suvorov, Dragan Uskoković, "Sintering effects on microstructure and electrical properties of CaCu₃Ti₄O₁₂ ceramics", In: *Processing and properties of advanced ceramics and composites V*, (Ceramic transactions, vol. 240), Narottam P. Bansal, ed., [S. l.], Wiley, 2013, vol. 240, pp. 337-342, 2013.
- Marija Vukomanović, Danilo Suvorov, "Novel approach for selective antibacterial proteins: hydroxyapatite/gold nanocomposite with functionalized surface", In: *MiMe - materails in medicine, 1st edition, October 8-11, Faenza, Italy: conference guide, final program and abstract book*, [S. l., s. n.], 2013, pp. 250.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

- Boštjan Jančar, Danilo Suvorov, "Microwave ceramics", In: *Ceramics science and technology. Volume 4, Applications*, Ralf Riedel, ed., I-Wei Chen, ed., Weinheim, Wiley-VCH Verlag GmbH, 2013, pp. 323-344.
- Sašo Šturm, Boštjan Jančar, "Microstructure characterization of advanced ceramics", In: *Advanced ceramics for dentistry*, Zhijian Shen, ed., Tomaž Kosmač, ed., Amsterdam ... [et al.], Elsevier, 2013, pp. 151-170.

PATENT APPLICATION

- Marija Vukomanović, Srečo D. Škapin, Danilo Suvorov, *Functionalized hydroxyapatite/gold composites as "green" materials with antibacterial activity and a process for preparing and use thereof*, WO2013187846 (A1), World Intellectual property organization, 19.12.2013.

PATENT

- Marija Vukomanović, Srečo D. Škapin, Danilo Suvorov, *Composites materials based on ceramic phase and metal with functionalized surface as environmentally-friendly materials with antibacterial activity, a process for preparing and use thereof*, SI24094 (A), Urad RS za intelektualno lastnino, 31.12.2013.

MENTORING

- Tina Šetinc, *Influence of synthesis methods on the functional properties of Na_{0.5}Bi_{0.5}TiO₃ (NBT), SrTiO₃ (ST) and NBT-ST composite material*: doctoral dissertation, Ljubljana, 2013 (mentor Danilo Suvorov; co-mentor Matjaž Spreitzer).

DEPARTMENT OF BIOCHEMISTRY, MOLECULAR AND STRUCTURAL BIOLOGY

B-1

The research activities of the members of the department are largely focused on studies of the physiological role of proteases in normal and pathological conditions, the mechanism of their action and regulation, as well as their properties and structure. Part of the activities is devoted to the development of tools that allow us to understand the properties of proteases and other enzymes, as well as to enable their monitoring and manipulation with respect to in vivo conditions.

Protease research has undergone a major expansion in the past decade, largely due to the extremely rapid development of new technologies, such as quantitative proteomics and *in vivo* imaging, as well as the extensive use of *in vivo* models. These have led to the identification of physiological substrates and resulted in a paradigm shift from the concept of proteases as protein-degrading enzymes to proteases as key signalling molecules. Their catalytic activities are precisely regulated; the most important ways being zymogen activation and inhibition by their endogenous protein inhibitors. Any imbalance of this regulation can lead to pathologies such as autoimmune, neurological and cardiovascular disorders, cancer and osteoporosis. However, protease signalling pathways are only partially understood. Currently, only a minor subset of physiological substrates for a limited number of proteases has been identified, and their physiological regulation is still not well understood.

We have continued our work in the apoptosis field with a major focus on cysteine cathepsins. The cathepsins are normally found within the endolysosomal vesicles, which contain an arsenal of hydrolases, including proteases such as cysteine cathepsins, but if released to the cytosol can initiate apoptosis signalling pathways. Endogenous and exogenous compounds have been identified that can mediate the destabilization of lysosomal membranes. It was shown that lysosomal proteases are not only able to initiate apoptotic signalling, but can also amplify the apoptotic pathways initiated in other cellular compartments. The endocytic pathway also receives cargo destined for degradation via the autophagic pathway. By recycling energy and biosynthetic substrates, and by degrading damaged organelles and molecules, the endocytic system assists the autophagic system in resisting apoptotic stimuli. In a critical review we have discussed steps leading to lysosomal membrane permeabilization and the subsequent triggering of cell death, as well as the therapeutic potential of intervention in lysosomal membrane permeabilization. We have also investigated the mechanism of action of the sigma-2 receptor agonist siramesine, which was shown to trigger the cell death of cancer cells and exhibit a potent anticancer activity *in vivo*. Initially, the compound was suggested to trigger lysosomal membrane permeabilization, but its mechanism of action remained poorly understood. We have shown that siramesine can induce rapid cell death in a number of cell lines at concentrations above 20 μM . In HaCaT cells, cell death was accompanied by caspase activation, the rapid loss of mitochondrial membrane potential, cytochrome c release, cardiolipin peroxidation and typical apoptotic morphology, whereas in U-87MG cells most apoptotic hallmarks were not notable, although mitochondrial membrane potential was rapidly lost. In contrast to the rapid loss of mitochondrial membrane potential above 20 μM siramesine, a rapid increase in lysosomal pH was observed for all the concentrations tested, which was, however, not accompanied by lysosomal membrane permeabilisation and the release of lysosomal enzymes into the cytosol. The lipophilic antioxidant -tocopherol, but not the hydrophilic antioxidant N-acetyl-cysteine, considerably reduced the cell death and destabilisation of mitochondrial membranes, but did not prevent the increase in lysosomal pH. At low concentrations, siramesine triggered cell death after two days or later, which seems to be associated with a general metabolic and energy imbalance due to defects in the endocytic pathway, intracellular trafficking and energy production, and not by a specific molecular event. Overall, we have shown that cell death in siramesine-treated cells is induced by the destabilisation of



Head:
Prof. Boris Turk

In 2013, we set up the first whole-body imaging platform in Slovenia, based on the IVIS Spectrum imaging system. This platform enables fluorescence and bioluminescence imaging in small animals, including 3-D image reconstruction, which is critical for the evaluation of novel diagnostic and therapeutic tools, as well as for the identification of in vivo signalling pathways.

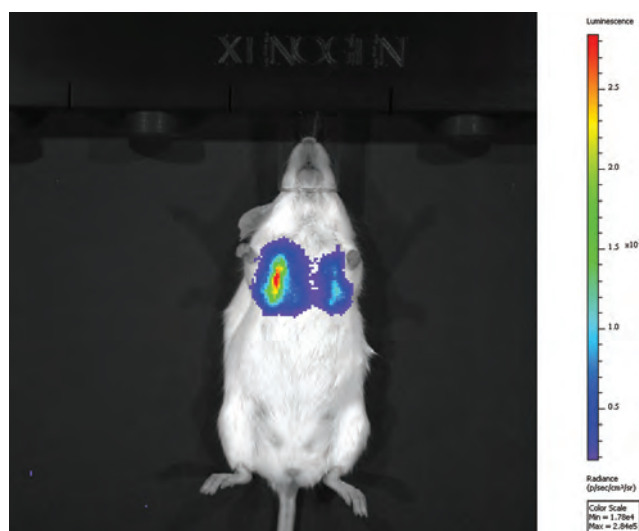


Figure 1: Lung colonization of tumor cells after i.v. injection

mitochondria and is independent of the lysosomal membrane permeabilisation and the release of cathepsins into the cytosol, which is important for the development of the next generation of siramesine analogues.

Further work, which at least partially involves cysteine cathepsins and cell death, was performed on the role of the endogenous inhibitor of cathepsins, stefin B, in cancer. To investigate its role in mammary cancer, stefin B null mice were crossed with transgenic mammary cancer model mice. We have shown that the ablation of stefin B resulted in the reduced size of mammary tumours, but did not affect their rate of metastasis. Importantly, the decrease in tumour growth was correlated with an increased incidence of dead cell islands detected in tumours of stefin B-deficient mice. An *ex vivo* analysis of primary mammary tumour cells revealed that upon treatment with the lysosomotropic agent Leu-Leu-OMe, cancer cells lacking stefin B exhibited a higher sensitivity to apoptosis. Moreover, stefin B-deficient tumour cells were significantly more prone to cell death under increased oxidative stress. These results indicate an *in vivo* role for stefin B in protecting cancer cells by promoting their resistance to oxidative stress and to apoptosis induced through the lysosomal pathway. In addition, several stefin B mutants, characteristic for a rare epilepsy form, were found to be partially unfolded, and thereby potential targets for proteolytic cleavages by cathepsins S and B. The co-localization of stefin B wild type and EPM1 mutants with cathepsins showed that the cathepsins accumulate around the aggregates formed by the mutants. We hypothesize that the aggregation of the full-length mutants prevents the cathepsins from accessing the substrate protein's core, whereas the cleaved fragments would be expected to aggregate more strongly. In addition to stefin B, also cathepsin F, a cysteine cathepsin with an unusual

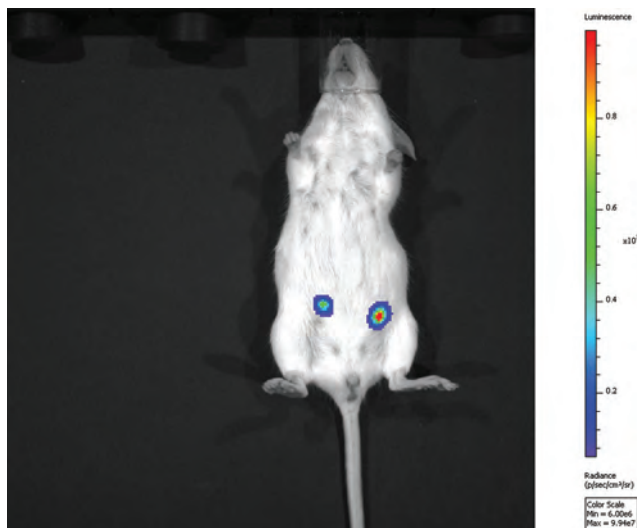


Figure 2: Orthotopic transplantation of tumor cells into mammary gland

cystatin domain in the prodomain was found to be linked with aggregation. Wild-type human cathepsin F was namely found to localize to lysosomes, whereas several of its N-terminally truncated forms were found to aggregate and accumulate within aggresome-like inclusions. These inclusions nicely co-localised with several autophagy markers, suggesting that autophagy is the major protective and prosurvival mechanism responsible for the clearance of the N-terminally truncated forms of human cathepsin F.

More work has been done on understanding protease function in health and disease. Osteoarthritis and rheumatoid arthritis are destructive joint diseases that involve the loss of articular cartilage with a potential implication of cysteine cathepsins. We have thus shown that stimulation of the cultivated chondrocytes with two cytokines, interleukin-1 α and/or tumour necrosis factor α , resulted in a time-dependent increase in cathepsin S expression and induced its secretion into the conditioned media. Using a novel bioluminescent activity-based probe, we were able to demonstrate a significant increase in proteolytic activity of cathepsin S in the conditioned media of proinflammatory cytokine-stimulated chondrocytes. Its stability at neutral pH and potent proteolytic activity on extracellular matrix components mean that cathepsin S may contribute significantly to cartilage degradation and may thus be considered a potential drug target in joint diseases.

We also worked on the identification of protease substrate specificities and on the development of proteomic methods for their identification. In collaboration with dr. M. Drag (University of Wroclaw) we determined, using

combinatorial libraries of fluorescent substrates, that unnatural amino acids increase the activity and specificity of synthetic substrates for human and malarial cathepsin C, a finding that may have much wider applications, also to other proteases. In addition, with prof. dr. K. Gevaert (University of Ghent) we have been collaborating on the development of novel proteomic methods for substrate profiling, and introduced a new method for in-solution sample preparation using microfilter devices, combined with the use of the so-called stage-tip protocol, which was successfully tested on cathepsins. In addition, prof. dr. D. Turk has continued to develop the MAIN software, which has been designed to interactively perform the complex tasks of macromolecular crystal-structure determination and validation. Using MAIN, it is possible to perform density modification, manual and semi-automated or automated model building and rebuilding, real- and reciprocal-space structure optimization and refinement, map calculations and various types of molecular structure validation. Using MAIN, it is possible to optimize non-crystallographic symmetry parameters and envelopes and to refine the structure in single or multiple crystal forms.

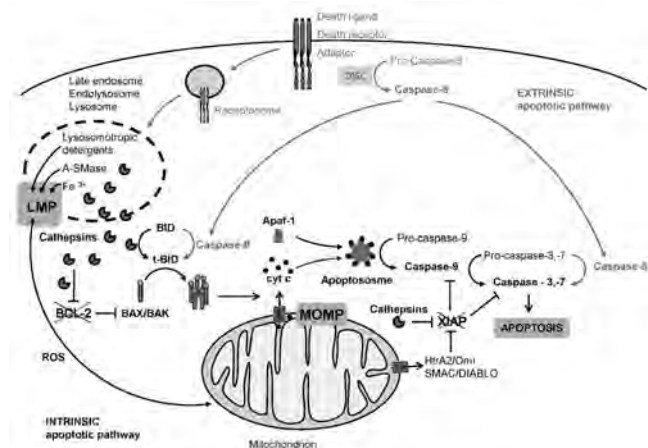


Figure 3: Schematic representation of apoptotic signaling pathways and the role of lysosomes (after Repnik et al., 2013, *CSH Perspectives in Biology* 5, a008755)

We participated in two FP7 projects, being the coordinators of one of them (LIVIMODE). We were also involved in two Slovenian Centers of Excellence, Center for Integrative approaches for Chemistry and Biology of Proteins (CIPKEBIP) that we also coordinate, and Nanosciences and Nanotechnologies. We were partners in the competence center BRIN, which, similarl to both Centers of Excellence, brings together researchers from both industry and academia. In addition, there are numerous other international collaborations with excellent research teams from different countries including Belgium, France, Germany, Sweden, Switzerland, UK, USA, Australia and Japan, which resulted in joint publications.

Prof. dr. Vito Turk was elected as a member of Slovene Academy of Sciences and Arts (SAZU), whereas prof. dr. Boris Turk was elected as a member of Academia Europea (London). Several members of the department were invited to give lectures at international symposia and foreign universities.

Some outstanding publications in the past year

1. Repnik, U., Hafner Česen, M., Turk, B. (2013): The endolysosomal system in cell death and survival. *Cold Spring Harb Perspect Biol.* 5(1):a008755. doi: 10.1101/cshperspect.a008755
2. Hafner Česen, M., Repnik, U., Turk, V., Turk, B. (2013): Siramesine triggers cell death through destabilisation of mitochondria, but not lysosomes. *Cell Death Dis.* 4:e818. doi: 10.1038/cddis.2013.361
3. Butinar, M., Prebanda Trstenjak, M., Rajković, J., Jerič, B., Stoka, V., Peters, C., Reinheckel, T., Krüger, A., Turk, V., Turk, B., Vasiljeva, O. (2013): Stefin B deficiency reduces tumor growth via sensitization of tumor cells to oxidative stress in a breast cancer model. *Oncogene*, doi: 10.1038/onc.2013.314
4. Turk, D. (2013): MAIN software for density averaging, model building, structure refinement and validation. *Acta Crystallogr D Biol Crystallogr.* 69, 1342–1357

Awards and appointments

1. Boris Turk: Member of Academia Europea, London, United Kingdom

Organization of conferences, congresses and meetings

1. 30th Winter School on Proteinases and Inhibitors, Tiers, Italy, 27. 2.–3. 3. 2013, coorganisers

Patent granted

1. S. G. Psakhie, Volia Isaevich Itin, D. A. Magajeva, O. G. Terehova, E. P. Najden, Olga Vasiljeva, Georgij Mihajlov Andrejevič, Urška Mikac, Boris Turk, Contrast agent for T1 and/or T2 magnetic resonant scanning and method for preparing it, RU2471502 (C1), Federal'naja služba po intelektual'n'noj so'stvennosti, 10.1.2013.

INTERNATIONAL PROJECTS

1. 7FP - ALEXANDER; Mucus Permeating Nanoparticulate Drug Delivery Systems
European Commission
Asst. Prof. Olga Vasiljeva
2. 7FP - LIVIMODE; Light-based Functional in Vivo Monitoring of Diseases Related Enzymes
European Commission
Prof. Boris Turk
3. MD Simulations of the Initial Steps in Oligomerization of an Amyloidogenic Protein Human Stefin B; in Comparison to the Less Amyloidogenic Stefin A
Slovenian Research Agency
Prof. Eva Žerovnik
4. Nuclear Inhibitors of Cysteine Proteinases Influence Heterochromatin Distribution in the Nucleus
Slovenian Research Agency
Asst. Prof. Nataša Kopitar - Jerala
5. The Role of Cystatins in Immune Response to Viruses
Slovenian Research Agency
Asst. Prof. Nataša Kopitar - Jerala
6. Protective role of cystatins in LPS induced oxidative stress and sepsis
Slovenian Research Agency
Asst. Prof. Nataša Kopitar - Jerala
7. Cofinancing of promotion of science and functioning of international scientific associations
European Commission
Prof. Boris Turk

RESEARCH PROGRAMS

1. Structural Biology
Prof. Dušan Turk
2. Proteolysis and Its Regulation
Prof. Boris Turk

R&D GRANTS AND CONTRACTS

1. Cell Signalling of Toll-like Receptors
Asst. Prof. Nataša Kopitar - Jerala
2. Secretory Vesicle Mobility and Calcium Homeostasis in Astrocytes
Prof. Veronika Stoka
3. Study of Hom(e)ologous Recombination in the Evolution of Polyketide Synthases
Prof. Boris Turk
4. The Role of Small GTPases in the Regulation of Endosomal/Lysosomal Transport in Astrocytes
Prof. Veronika Stoka
5. Nitroxoline and Its Derivatives as New Antitumour Drugs
Asst. Prof. Olga Vasiljeva
6. The Role of Cysteine Cathepsins in Cellular Signalling
Prof. Boris Turk
7. Role and Relevance of Empirical Geometric Parameters in Crystal Structure Determination of Macromolecules for Prediction of Ligand Binding
Prof. Dušan Turk

8. Involvement of the Lysosomal Cysteine Peptidase Inhibitors in Progression and Metastasis of Mammary Cancer
Asst. Prof. Olga Vasiljeva
9. Inhibitors of Cysteine Carboxypeptidases as Regulators of Autoimmune and Neurodegenerative Processes
Asst. Prof. Olga Vasiljeva
10. Oligomers of Amyloidogenic Proteins from A to Z: Biophysical Properties, Structure, Function and Mutual Interactions
Prof. Eva Žerovnik
11. Role of Cysteine Proteases in the Process of Cancerogenesis
Asst. Prof. Marko Fonovič
12. Research on New Technologies for Conservation - Restoration of Baroque Easel Paintings
Asst. Prof. Marko Fonovič
13. Use of Adipose-derived Stem Cells for Engineering Vascularized Tissue Implants
Dr. Mirjam Fröhlich
14. Competency Centre for Biotechnological Development and Innovation: CC BDI
Prof. Boris Turk

VISITORS FROM ABROAD

1. Georgy Mikhaylov, Siberian State Medical University, Tomsk, Russia, 1. 1.-31. 12. 2013 (IJS fellowship holder)
2. Andrey Kadin, Shemyakin and Ovchinnikov Institute of Bioorganic Chemistry, Russian Academy of Science, Moscow, 1. 1.-31. 12. 2013 (IJS fellowship holder)
3. Prof. Kazuo Umezawa, Department of Molecular Target Medical Screening, School of Medicine, Aichi Medical University, Nagakute, 20.-21. 9. 2013
4. Prof. Kris Gevaert, VIB Department of Medical Protein Research, UGent Proteome Analysis and Bioinformatics Unit, Gent, Belgium, 14.-15. 11. 2013

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50. Polonca Pirš Kovačič
51. Barbara Vrtačnik

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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Dejan Caglič *et al.* (12 authors), "The proinflammatory cytokines interleukin-1 α and tumor necrosis factor promote the expression and secretion of proteolytically active cathepsin S from human chondrocytes", *Biol Chem*, vol. 394, no. 2, pp. 307-316, 2013.
2. Hung Y. Fan, D. S. Hitchcock, R. D. Seidel, B. Hillerich, H. Lin, S. C. Almo, Andrej Šali, B. K. Shoichet, Frank M. Raushel, "Assignment of pterin deaminase activity to an enzyme of unknown function guided by homology modeling and docking", *J. Am. Chem. Soc.*, vol. 135, no. 2, pp. 795-803, 2013.
3. Ethan Geier, Avner Schlessinger, Hung Y. Fan, J. E. Gable, Andrej Šali, John J. Irwin, Kathleen M. Giacomini, "Structure-based ligand discovery for the Large-neutral Amino Acid Transporter 1, LAT-1", *Proc. Natl. Acad. Sci. U. S. A.*, vol. 110, issue 14, pp. 5480-5484, 2013.
4. Helena Gradišar, Sabina Božič, Tibor Doles, Damjan Vengust, Iva Hafner Bratkovič, Alenka Mertelj, Ben Webb, Andrej Šali, Sandi Klavžar, Roman Jerala, "Design of a single-chain polypeptide tetrahedron assembled from coiled-coil segments", *Nature chemical biology*, vol. 9, issue 6, pp. 362-366, 2013.
5. Maruša Hafner Česen, Urška Repnik, Vito Turk, Boris Turk, "Siramesine triggers cell death through destabilisation of mitochondria, but not lysosomes", *Cell death & disease*, vol. 4, pp. e818-1-e818-13, 2013.
6. Barbara Jerič, Iztok Dolenc, Marko Mihelič, Martina Klarič, Tina Zavašnik-Bergant, Gregor Gunčar, Boris Turk, Vito Turk, Veronika Stoka, "N-terminally truncated forms of human cathepsin F accumulate in aggresome-like inclusions", *Biochim. biophys. acta, Mol. cell res.*, vol. 1833, no. 10, pp. 2254-2266, 2013.
7. Mihaela Jurdana, Maja Čemažar, Katarina Pegan, Tomaž Marš, "Effect of ionizing radiation on human skeletal muscle precursor cells", In: Articles from 7th Conference of experimental and translational oncology, April, 20-24, 2013, Portorož, *Radiol. Oncol.*, vol. 47, no. 4, pp. 376-381, 2013.
8. Benjamin Kirm, Vasilka Magdevska, Miha Tome, Marinka Horvat, Katarina Karničar, Marko Petek, Robert Vidmar, Špela Baebler, Polona Jamnik, Štefan Fujs, Jaka Horvat, Marko Fonovič, Boris Turk, Kristina

Gruden, Hrvoje Petković, Gregor Kosec, "SACE_5599, a putative regulatory protein, is involved in morphological differentiation and erythromycin production in *Saccharopolyspora erythraea*", *Microb Cell Fact*, vol. 12, pp. 126-1-126-15, 2013.

9. Marina Klemenčič, Marko Novinec, Silke Maier, Ursula Hartmann, Brigita Lenarčič, "The heparin-binding activity of secreted modular calcium-binding protein 1 (SMOC-1) modulates its cell adhesion properties", *PLoS one*, vol. 8, no. 2, art. no. e56839 (12 pp.), 2013.
10. Jakob Kljun, Ioannis Bratsos, Enzo Alessio, George Psomas, Urška Repnik, Miha Butinar, Boris Turk, Iztok Turel, "New uses for old drugs: Attempts to convert quinolone antibacterials into potential anticancer agents containing ruthenium", *Inorg. chem.*, vol. 52, no. 15, pp. 9039-9052, 2013.
11. Urša Pečar Fonovič, Zala Jevnikar, Matija Rojnik, Bojan Doljak, Marko Fonovič, Polona Jamnik, Janko Kos, "Profilin 1 as a target for cathepsin X activity in tumor cells", *PLoS one*, vol. 8, iss. 1, pp. 1-9, e53918, 2013.
12. Børn P. Pedersen *et al.* (12 authors), "Crystal structure of a eukaryotic phosphate transporter", *Nature (Lond.)*, vol. 496, april 2013, pp. 533-536, 2013.
13. Ursula Pieper *et al.* (18 authors), "Coordinating the impact of structural genomics on the human α -helical transmembrane proteom", *Nat struct. mol. biol.*, vol. 29, no. 2, pp. 135-138, 2013.
14. Mira Polajnar, Robert Vidmar, Matej Vizovišek, Marko Fonovič, Nataša Kopitar-Jerala, Eva Žerovnik, "Influence of partial unfolding and aggregation of human stefin B (cystatin B) EPM1 mutants G50E and Q71P on selective cleavages by cathepsins B and S", *Biol Chem*, vol. 394, issue 6, pp. 783-790, 2013.
15. Nina Prezelj, Petra Nikolič, Kristina Gruden, Maja Ravnikar, Marina Dermastia, "Spatiotemporal distribution of flavescence dorée phytoplasma in grapevine", *Plant Pathol.*, vol. 62, no. 4, pp. 760-766, 2013.
16. Urška Repnik, Maruša Hafner Česen, Boris Turk, "The endolysosomal system in cell death and survival", *Cold Spring Harbor perspect. biol.*, vol. 5, no. 1, pp. a008755-1-a008755-14, 2013.
17. Nejc Rojko, Katarina Kristan, Gabriella Viero, Eva Žerovnik, Peter Maček, Mauro Dalla Serra, Gregor Anderluh, "Membrane damage by an [alpha]-helical pore forming protein Equinatoxin II proceeds through succession of ordered steps", *J Biol Chem*, vol. 288, issue 33, 23704-23715, 2013.
18. Parthasarathy Sampathkumar *et al.* (19 authors), "Structure, dynamics, evolution, and function of a major scaffold component in the nuclear pore complex", *Structure (Lond.)*, vol. 21, no. 4, pp. 560-571, 2013.
19. Jure Škraban, Sašo Džeroski, Bernard Ženko, Livija Tušar, Maja Rupnik, "Changes of poultry faecal microbiota associated with *Clostridium difficile* colonisation", *Vet. microbiol.*, vol. 165, iss. 3/4, pp. 416-424, 30 Aug. 2013.
20. Ajda Taler-Verčič *et al.* (13 authors), "The role of initial oligomers in amyloid fibril formation by human stefin B", *Int. j. mol. sci.*, vol. 14, no. 9, pp. 18362-18384, 2013.
21. Ana Torkar, Brigita Lenarčič, Tamara Lah Turnšek, Vincent Dive, Laurent Devel, "Identification of new peptide amides as selective cathepsin L inhibitors: the first step towards selective irreversible inhibitors?", *Bioorg. med. chem. lett.*, vol. 23, issue 10, pp. 2968-2973, 2013.
22. Dušan Turk, "MAIN software for density averaging, model building, structure refinement and validation", *Acta crystallogr., D, Biol. crystallogr.*, vol. 69, part 8, pp. 1342-1357, 2013.
23. Tilen Vidmar, Miha Pavšič, Brigita Lenarčič, "Biochemical and preliminary x-ray characterization of the tumor-associated calcium signal transducer 2 (Trop2) ectodomain", *Protein expr. purif.*, vol. 91, no. 1, pp. 69-76, 2013.
24. Andrew D. Ward, Andrej Šali, Ian A. Wilson, "Integrative structural biology", *Science (Wash. D.C.)*, vol. 339, no. 6122, pp. 913-915, 2013.
25. Patrick Weinkam, Chen, Jaume Pons, Andrej Šali, "Impact of mutations on the allosteric conformational equilibrium", *J. mol. biol.*, vol. 425, no. 3, pp. 647-661, 2013.

REVIEW ARTICLE

1. Marko Novinec, Brigita Lenarčič, "Cathepsin K: a unique collagenolytic cysteine peptidase", *Biol Chem*, vol. 394, no. 9, pp. 1163-1179, 2013.
2. Marko Novinec, Brigita Lenarčič, "Papain-like peptidases: structure, function, and evolution", *Biomol. concepts*, vol. 4, issue 3, pp. 287-308, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Nevenka Kregar-Velikonja, Ariana Barlič, Mirjam Fröhlich, Miomir Knežević, "Gojenje hondrocitov za zdravljenje poškodb sklepne hrustanca", In: *Sodobni pristopi pri zdravljenju s krvjo, celicami in tkivi: zbornik z recenzijo*, Cvetka Gregorc, ed., Ljubljana, Zbornica zdravstvene in babiške nege Slovenije - Zveza društev medicinskih sester, babc in zdravstvenih tehnikov Slovenije, Sekcija medicinskih sester in zdravstvenih tehnikov v anesteziologiji, intenzivni terapiji in transfuziologiji, 2013, pp. 52-58.
2. Veronika Stoka, Vida Puizdar, Barbara Jerič, Tajana Zajc, Katja Bidovec, Iztok Dolenc, Vito Turk, "Role of cathepsins D and F in human neuronal ceroid lipofucinosi", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 366-369.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Antonio Baici, Marko Novinec, Brigita Lenarčič, "Kinetics of the interaction of peptidases with substrates and modifiers", In: *Proteases: structure and function*, Klaudia Brix, ed., Walter Stöcker, ed., Wien, Springer-Verlag, cop. 2013, pp. 37-84.
2. Iztok Dolenc, Boris Turk, "Plasma glutamate carboxypeptidase", In: *Handbook of proteolytic enzymes*, Neil D. Rawlings, ed., Guy S. Salvesen, ed., 3rd ed., Boston, London, Academic Press, 2013, pp. 1707-1710.
3. Nataša Kopitar-Jerala, "Cysteine proteinase Inhibitors in the nucleus and nucleolus in activated macrophages", In: *Proteins of the nucleolus regulation, translocation, & biomedical functions*, Danton H. O'Day, ed., Andrew Catalano, ed., [S. l.], Springer, 2013, pp. 305-322.
4. Nataša Mehle, Petra Nikolič, Kristina Gruden, Maja Ravnikar, Marina Dermastia, "Real-time PCR for specific detection of three phytoplasmas from the apple proliferation group", In: *Phytoplasma: methods and protocols*, (Methods in Molecular Biology, vol. 938), (Springer Protocols), Matthew Dickinson, ed., Jennifer Hodgetts, ed., New York, Humana Press, 2013, pp. 269-281.
5. Nataša Mehle, Petra Nikolič, Matevž Rupar, Jana Boben, Maja Ravnikar, Marina Dermastia, "Automated DNA extraction for large numbers of plant samples", In: *Phytoplasma: methods and protocols*, (Methods in Molecular Biology, vol. 938), (Springer Protocols), Matthew Dickinson, ed., Jennifer Hodgetts, ed., New York, Humana Press, 2013, pp. 139-145.
6. Boris Turk, Dušan Turk, Iztok Dolenc, Vito Turk, "Dipeptidyl-peptidase. I", In: *Handbook of proteolytic enzymes*, Neil D. Rawlings, ed., Guy S. Salvesen, ed., 3rd ed., Boston, London, Academic Press, 2013, pp. 1969-1974.

PATENT APPLICATION

1. Marko Šnajder, Marko Mihelič, Dušan Turk, Nataša Poklar Ulrih, *Overproducing recombinant pernisine in heterologous expression systems*, P-201300110, Urad RS za intelektualno lastnino, 6.5.2013.

PATENT

1. S. G. Psakhie, Volia Isaevich Itin, D. A. Magajeva, O. G. Terehova, E. P. Najden, Olga Vasiljeva, Georgij Mihajlov Andrejevič, Urška Mikac, Boris Turk, *Contrast agent for T1 and/or T2 magnetic resonant scanning and method for preparing it*, RU2471502 (C1), Federal'naja služba po intelektual'n'noj so'stvennosti, 10.1.2013.

MENTORING

1. Maruša Hafner Česen, *The effect of siramesine on cell death pathway and comparison to other lysosomotropic reagents*: doctoral dissertation, Ljubljana, 2013 (mentor Vito Turk; co-mentor Boris Turk).
2. Marina Klemenčič, *Role of the SMOC-1 and SMOC-2 proteins in extracellular matrix*: doctoral dissertation, Ljubljana, 2013 (mentor Brigita Lenarčič).
3. Mira Polajnar, *Gain of toxic and loss of normal functions of human stefin B EPM1 mutants*: doctoral dissertation, Ljubljana, 2013 (mentor Eva Žerovnik).

DEPARTMENT OF MOLECULAR AND BIOMEDICAL SCIENCES

B-2

The research program of the Department of Molecular and Biomedical Sciences is focused mainly on basic research in protein biochemistry, molecular and cellular biology, and genetics. The primary goal of our investigations is the acquisition of a new understanding of mammalian pathophysiology with the aim of improving human and animal health.

Secreted phospholipases A₂

One of the major research topics of the department is secreted phospholipases A₂ (sPLA₂s) originating from animal toxins as well as those found in humans. We are studying the molecular mechanisms of action of the toxic sPLA₂s, particularly those endowed with presynaptic neurotoxicity, and the role of endogenous sPLA₂s in pathological and physiological processes in mammals.

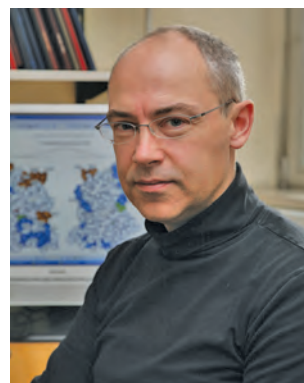
We have been invited to prepare a review for a monograph entitled "Genetic Manipulation of DNA and Protein – Examples from Current Research" (T. Petan et al., *InTech Open Access*, (2013), 107–132). In this overview, our successful protein-engineering approach in the structure-function studies of sPLA₂s from viperid venoms was presented.

By developing innovative procedures to renature recombinant sPLA₂s we tried to obtain an enzymatically inactive form of ammodytoxin A (AtxA), a neurotoxic sPLA₂ from the venom of the nose-horned viper (*Vipera ammodytes ammodytes*). The results are encouraging, and we expect that we will be able to produce a sufficient amount of the correctly folded protein in the next year. This will enable an accelerated characterization of novel sPLA₂ receptors, an advance in the study of the translocation mechanisms of these molecules through a plasma membrane and between different compartments in the cell, as well as intracellular trafficking of the sPLA₂ in real time. We study the molecular mechanism of action of presynaptically neurotoxic sPLA₂s also using OS₂ from the venom of the Australian taipan (*Oxyuranus scutellatus scutellatus*). AtxA and OS₂ are structurally different sPLA₂s. The first belongs to the group II, and the second to the group I sPLA₂s. As model molecules, they are therefore complementary. The identification of an sPLA₂ receptor in the presynaptic membrane of a motoneuron (N-sPLA₂R), which is crucial for the expression of neurotoxicity, has been a large research challenge already for many years. OS₂ binds to this receptor with an affinity 1000-fold higher than that of AtxA; therefore, it represents an ideal ligand for the study of N-sPLA₂R. Following the preparation of large quantities of the recombinant wild-type OS₂ and its chimera with similar, but non-toxic, OS₁, from the venom of the same snake, we continued in 2013 the collaboration with a research group from the Institute of Molecular and Cellular Pharmacology of the National Centre for Scientific Research (CNRS), Valbonne, France, in the scope of an international bilateral project Proteus, by developing a procedure for the preparation of the photo-reactive derivatives of these sPLA₂s. The derivatives are currently being characterized.

sPLA₂s represent a physiologically very important family of multifunctional proteins, whose effects do not depend solely on their enzymatic activity but, in some cases, also on their ability to bind to other molecules. We have been searching for new sPLA₂-binding molecules using immuno-affinity chromatography. In this way, we identified an Atx-binding protein in the venom of the nose-horned viper, which inhibited the activity of chymotrypsin (ChI), structurally belonging to the Kunitz-type proteinase inhibitors. Interestingly, the first results show that the toxicity of AtxA is increased in the presence of ChI. ChI-like molecules are present in mammals. It will be interesting to analyse the affinity of these molecules to sPLA₂s and the physiological consequences of their interaction with sPLA₂ (M. Brgles et al., *Analytical and Bioanalytical Chemistry*, in press).

Following demonstrations that sPLA₂s can also act inside cells, we continue to study the intracellular activities of these molecules using different cellular models. In 2013 we tested the hypothesis of the molecular mechanism of AtxA action, based on our results obtained on the yeast *Saccharomyces cerevisiae*, by which AtxA inhibits endocytosis, on a mammalian cellular model, the isolated mouse neuromuscular junction. By characterising an enzymatically active mutant of the catalytically inactive, non-neurotoxic ammodytin L (AtnL), AtnL-LW, we also confirmed the validity of the model in mammalian cells. Restoration of the enzymatic activity conferred to AtnL both the ability to inhibit endocytosis in yeast and to act as a presynaptically neurotoxic sPLA₂ at the mammalian neuromuscular junction (N. Vardjan et al., *Communicative and Integrative Biology*, 6 (2013), e23600).

We studied the intracellular action of Atx also on mammalian cell lines, murine NSC34 and rat PC12. We performed a confocal-microscopy study of the translocation dynamics of Atx into PC12 cells. Using the same technique,



Head:

Prof. Igor Krizaj

New substances and molecular tools to improve human and animal health.

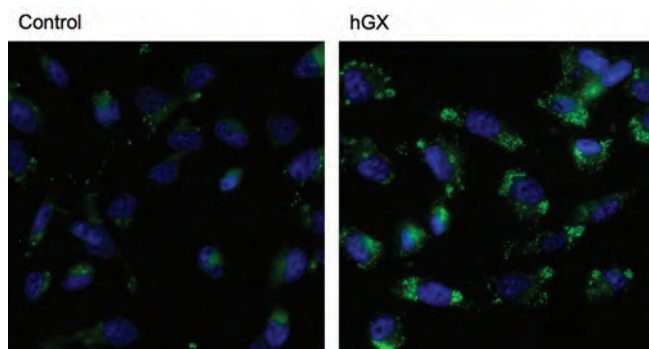


Figure 1: Human group X sPLA₂ induces triacylglycerol synthesis and lipid droplet (LD) formation in MDA-MB-231 cells in an enzymatic activity-dependent manner. The cells were grown in a complete culture medium in the presence of 1 nM hGX for 48 h, fixed, stained with Nile red to visualise the LDs (green) and DAPI to visualise the nuclei (blue). Note a significant increase in the amount of LDs in hGX-treated cells in comparison with a non-treated control. The figure is reproduced from A. Pucer et al., *Molecular Cancer*, 12 (2013), e111.

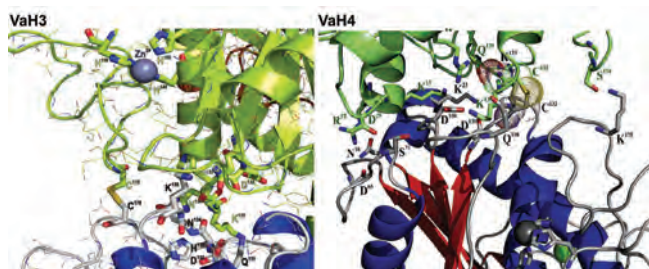


Figure 2: Comparative display of the interacting areas between subunits in VaH3 and VaH4. In the case of VaH3, a disulphide bond between the subunits forms between two Cys176 residues. In the case of VaH4, an intra-subunit disulphide bond is formed, however, between two Cys132 residues. Therefore, P-IIIc SVMP can be divided into two groups, one possessing a Cys132-Cys132 and the other a Cys174-Cys174 intra-subunit disulphide bond connection. The figures are reproduced from T. Sajevec et al., *Biochimie*, 95 (2013), 1158-1170 in A. Leonardi et al., *Toxicol*, 77 (2014), 141-155.

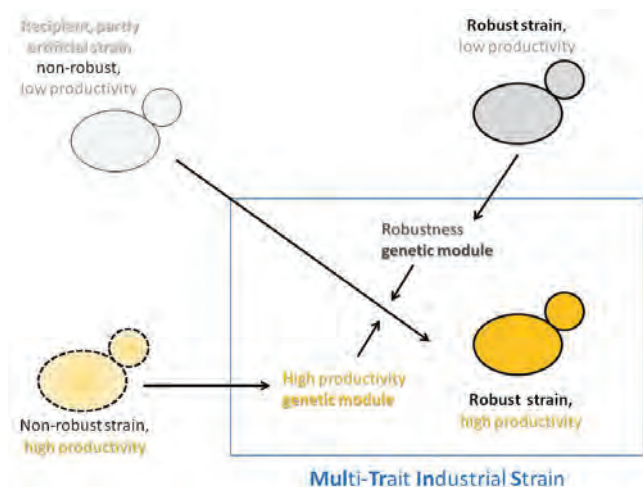


Figure 3: Metabolic engineering and industrial biotechnology are expected to gain a lot using the transfer of genetic modules into industrial microorganisms.

we determined the level of co-localization between Atx and mitochondria, as well as Atx and several intracellular proteins, following the internalisation of Atx into PC12 cells. The results are prepared for publication.

We published a paper clearly demonstrating that ammodytoxins efficiently release arachidonic acid (AA) and induce apoptosis in a motoneuronal cell line in an enzymatic activity-dependent manner (Z. Jenko-Pražnikar et al., *NeuroToxicology*, 35 (2013), 91-100). The role of sPLA₂ enzymatic activity, including AA release, in the induction of motoneuronal apoptosis has been studied by AtxA and homologous recombinant sPLA₂s with different enzymatic properties. We analysed the effects of an AtxA(V31W) mutant with a very high enzymatic activity, enzymatically inactive S49-sPLA₂ (AtnL), its mutant with restored enzymatic activity (AtnL-LW), and non-toxic, enzymatically active sPLA₂ (AtnL₂). The addition of AA, AtxA, AtxA(V31W) and AtnL-LW, but not AtnL and AtnL₂, to motoneuronal cells resulted in caspase-3 activation, DNA fragmentation and disruption of the mitochondrial membrane potential, leading to a significant and rapid decrease in motoneuronal cell viability that was not observed in (control) mouse myoblast and human embryonic kidney cells. AtxA, AtxA(V31W) and AtnL-LW, but not AtnL and AtnL₂, also liberated large amounts of AA specifically from motoneuronal cells, and this ability correlated well with the ability to induce apoptotic changes and decrease cell viability. The enzymatic activity of AtxA and similar sPLA₂s is thus necessary, but not sufficient, for inducing motoneuronal apoptosis. These results suggests that specific binding to the motoneuronal cell surface, followed by internalisation and the enzymatic activity-dependent induction of apoptosis, possibly as a consequence of both extensive extra- and intracellular AA release, is necessary for Atx-induced motoneuronal cell death.

In 2013 a postdoctoral research project was concluded in the scope of which a detailed structural analysis of the interaction between Atx and calmodulin (CaM) has been studied by protein NMR spectroscopy. CaM is a regulatory protein in the cell cytosol, presumably very important for the intracellular activity of Atx and homologous mammalian sPLA₂s. Understanding on the atomic level of its interaction with sPLA₂s, as well as of the interaction of the sPLA₂-CaM complexes with the phospholipid membrane, is very important for designing the regulation of these interactions. In collaboration with two partner groups, the Bijvoet Centre from the Utrecht University, the Netherlands, and the NMR centre from the National Institute of Chemistry in Ljubljana, we finished with the planned experimental work. The data processing and the preparation of publications are underway.

Aiming to dynamically observe the interaction between Atx and CaM in cells using a FRET method, we continued the development of fluorescent derivatives of both proteins.

In an attempt to formulate a protocol for the preparation of an effective antiserum against the nose-horned viper venom, we discovered that the quantity of Atx in the venom positively correlates with the level of venom immunogenicity. A rapid and accurate method for the quantification of Atx in the venom is therefore one of the key steps in preparing the antisera of a high quality. Together with colleagues from the Institute for Chemical Technologies and Analytics, Vienna University of Technology, we made another step forward in the efficient quantification of Atx in the venom. We developed an original method that is able to separate, in a single step, all three highly similar Atx isoforms (V.U. Weiss et al., *Electrophoresis*, in press).

It has been shown that nine active sPLA₂ enzymes known in humans display different tissue expression patterns and specific enzymatic preferences for binding to different types of phospholipid membranes, suggesting distinct biological roles for each sPLA₂. The multitude of cellular effects of the released free fatty acids (FFAs) and lysophospholipids, and of their numerous bioactive metabolites, further explain their involvement in a variety of

physiological processes and diseases, including lipid digestion and remodelling, acute and chronic inflammatory diseases, cardiovascular diseases, reproduction and host defence against infections. Recent studies have confirmed that various sPLA₂s also play a significant role in cancer and metabolic disorders. For example, a few years ago, it was demonstrated that the human group X (hGX) sPLA₂ stimulates colon-cancer cell proliferation by a mechanism dependent on the released FFAs and lysophospholipids, but not on its potent stimulation of prostaglandin E₂ synthesis. The underlying mechanisms of the action of hGX sPLA₂ and other sPLA₂ enzymes in different cancers have not been known and confirmations of their functional contribution to tumorigenesis have been waiting for additional studies. In 2013, we successfully completed and published an extensive study, using multiple breast-cancer cellular models, analysing the effects of hGX sPLA₂ on breast-cancer cell growth and survival in details, with an aim to better understand its mechanism of action (Pucer et al., *Molecular Cancer*, 12 (2013), e111). We were able to show for the first time that hGX sPLA₂ induces lipid droplet (LD) formation in the highly tumorigenic MDA-MB-231 breast-cancer cells (Figure 1) in an enzyme activity-dependent manner, thereby stimulating cell proliferation and significantly prolonging cell survival under serum deprivation-induced stress. Our results suggested that FFAs, in particular oleic acid, released from membrane phospholipids by the action of hGX sPLA₂, are substantially responsible for the LD biogenesis and cell survival. We also demonstrated that the mechanism of hGX-induced cell survival and lipid accumulation is associated with alterations in the expression of key lipogenic and β -oxidation enzymes, and the modulation of AMP-activated protein kinase (AMPK) and protein B/Akt kinase signalling pathways. The pro-tumorigenic effects induced by hGX sPLA₂ were abolished by etomoxir, suggesting a critical role for β -oxidation in hGX-induced LD formation and cell survival in breast-cancer cells. The ability of hGX sPLA₂ to act as a modulator of basic lipid metabolism and cancer cell survival is thus well established. This could have important implications in elucidating the role of hGX and other sPLA₂s, such as hGV and hGIII, in cancer and human pathophysiology in general.

The experience of our group in the field of sPLA₂ is also evidently well known to the editors of *Protein and Peptide Letters*, as they invited us to prepare a review article on the role of these molecules in the mammalian immune system (I. Križaj, *Protein and Peptide Letters*, in press).

Other pharmacologically active components from natural toxins

In 2013 we continued to systematically analyse the components of the nose-horned venom that affect the blood-coagulation process – haemostasis. We succeeded in publishing a description of one of the most haemorrhagic molecules from the venom, homodimeric metalloproteinase (SVMP) VaH3 (T. Sajevec et al., *Biochimie*, 95 (2013), 1158–1170). We also concluded with the experimental work on a heterodimeric, haemorrhagic SVMP, VaH4, and published these results (A. Leonardi et al., *Toxicon*, 77 (2014), 141–155). A very important conclusion stems from our analysis: in P-III class of SVMPs, dimers can be formed by a covalent inter-subunit crosslinking of either two Cys132 or two Cys174 residues (Figure 2). Due to our achievements in the field of haemostatically-active components from snake venoms and connected pathologies we have been invited to submit a review article (T. Sajevec et al., *Toxin Reviews*, in press). In collaboration with our colleagues from the Institute of Immunology in Zagreb, Croatia, and the Vienna University of Technology we described another very interesting molecule from the venom of the nose-horned viper, a serine proteinase VaSP1 with the unconventional active site structure (T. Kurtović et al., *Toxicon*, 77 (2014), 93–104). Regarding the substrate specificity of this enzyme and the fact that it prolongs the prothrombin and activated partial thromboplastin times, it is very likely that it acts as anticoagulant.

High-throughput genetics and functional genomics in yeast *Saccharomyces cerevisiae*

Neonicotinoid insecticides were notorious in 2013 because of their proposed toxicity for bees and other non-target organisms, on the basis of which they were banned in the EU in April 2013. Using chemogenomics analysis in the yeast model we have determined the side effects of neonicotinoid insecticides, and especially of additives from

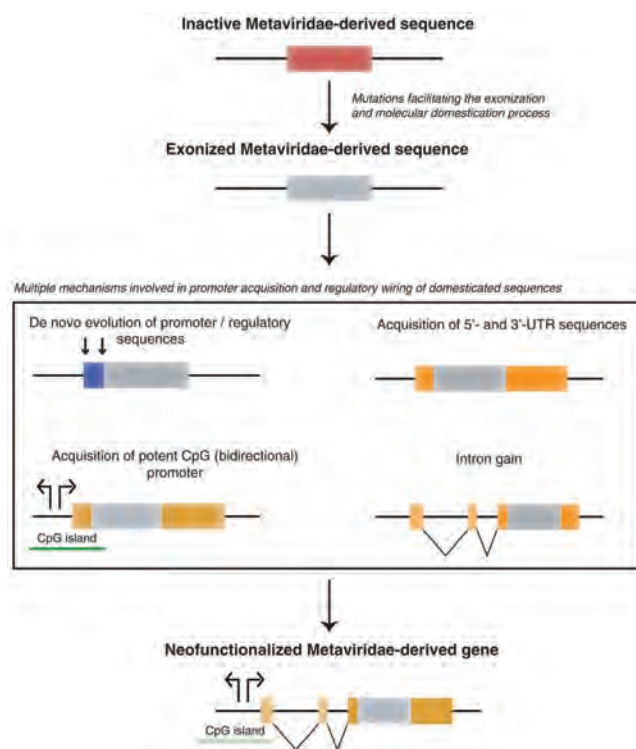


Figure 4: Mechanisms involved in the process of the retroelement-derived domesticated gene (RDDG) neofunctionalisation. In the transition phase from retroelement remains to the first RDDGs, many nucleotide changes were necessary for the neofunctionalisation. One of the crucial steps in the process of neofunctionalisation was the exonisation of retroelement domains (Gag, protease, and integrase), which produced ready-to-use modules. Retroelement remains in mammalian genomes will normally turn into pseudogenes, due to lack of a promoter, and they can survive as a functional gene only if they recruit a new promoter sequence. To become expressed at a significant level and in the tissues where it can exert a selectively beneficial function, a new gene needs to acquire a core promoter and other structural elements that regulate its expression. Exons and introns are shown as orange (5'- and 3'-untranslated regions - UTRs) or grey (coding part of the exons) boxes and connecting lines. A de novo acquired promoter is shown in blue. The figure is reproduced from J. Kokošar and D. Kordiš, *Molecular Biology and Evolution*, 30 (2013), 1015–1031.

insecticide formulations. We have shown examples where the additives are even more toxic than the neonicotinoids themselves (M. Mattiazzi Ušaj et al., *Chemosphere*, in press).

In the field of genetics, the last years have seen a rapid development of techniques and methods for polygenic traits analysis, which have been spurred by recent developments in genomics. In our group we have been developing new experimental approaches and computational tools that will enable the transfer of combinations of genes (*i.e.*, genetic modules) in industrial microorganisms (Figure 3), which will revolutionise the field of metabolic engineering and industrial biotechnology.

The regulation of cellular processes through internal metabolic intermediates is one of the most exciting areas of molecular biology, which should contribute to new treatments for cancer, type-2 diabetes and neurodegenerative diseases. Acetyl-CoA is the key metabolite that broadly affects cellular processes. In 2013 we have finished our multiyear study on the regulation of cellular metabolism through a peroxisomal protein Pex11. We established that

Pex11 regulates the cytosolic concentration of acetyl-CoA, which makes Pex11 an interesting novel drug target.

Our colleague from the department, currently a postdoc at the University of Toronto, Canada, took part in the preparation of a review article about the contribution of the functional genomics and high-throughput methods to the studies of the cell polarity in yeast (E. Styles et al., *Philosophical Transactions of the Royal Society B Biological Sciences*, 368 (2013), 20130118).

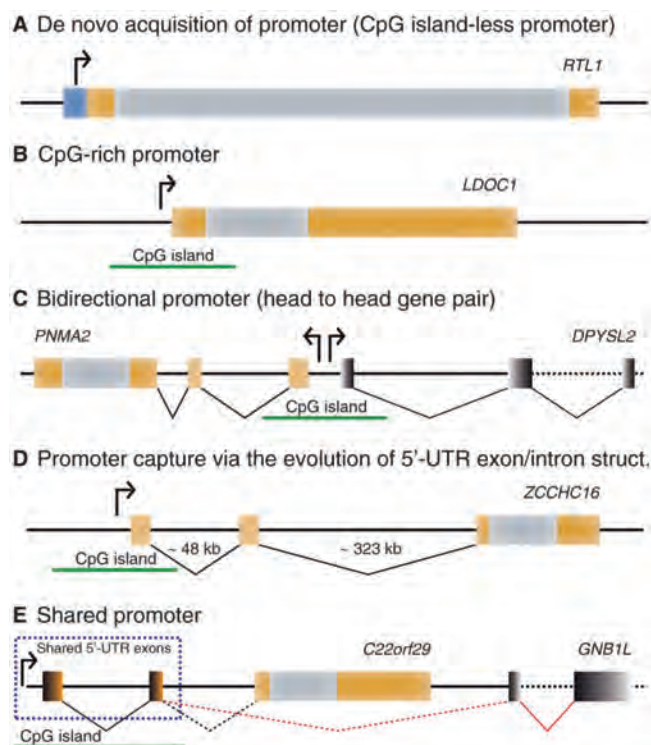


Figure 5: Diverse sources of the retroelement-derived domesticated gene (RDDG) promoters. Various scenarios that lead to the transcription of RDDG copies are illustrated. (A) Recruitment of proto-promoters from the CpG island-less region. (B) Recruitment of proto-promoters from the CpG-rich island. (C) Recruitment of a bidirectional (CpG-enriched) promoter from neighbouring gene in the vicinity of the RDDG. (D) Recruitment of distant promoters in the genomic neighbourhood by the acquisition of a new 5'-untranslated (UTR) exon-intron structure. (E) Sharing of the unidirectional (CpG-enriched) promoter from a neighbouring gene in the vicinity of the RDDG. Exons and introns are represented by orange and grey (RDDGs) or black (neighbouring genes in the case of bidirectional promoters) boxes and connecting lines. Distances between exons are not to scale. The figure is reproduced from J. Kokošar and D. Kordiš, *Molecular Biology and Evolution*, 30 (2013), 1015–1031.

as placenta and newly evolved brain functions. DGs could thus constitute an excellent system on which to analyse the mechanisms of regulatory evolution in placental mammals.

In 2013 we participated in a study led by our colleagues from the Faculty of Chemistry and Chemical Technology, University of Ljubljana (UL), about the way in which the APOBEC3 proteins inhibit the multiplication of the L2-retrotransposon. Clarification of the mechanism of action of APOBEC3 proteins is very important as these proteins inhibit the multiplication of numerous retrotransposons and retroviruses, among them also the HIV virus (N. Lindič et al., *Retrovirology*, 10 (2013), e156).

Other subjects

In 2013 we also worked on several projects out of the thematic scope of our department.

Evolutionary genomics and study of retrotransposons

Vertebrates, especially mammals, possess numerous single-copy domesticated genes (DGs) that originated from the intronless multicopy transposable elements. However, the origin and evolution of the retroelement-derived DGs (RDDGs) that originated from Metaviridae has only been partially elucidated, due to the absence of genome data or a limited analysis of a single family of DGs. We traced the genesis and regulatory wiring of the Metaviridae-derived DGs through phylogenomic analysis, using whole-genome information from more than 90 chordate genomes (J. Kokošar and D. Kordiš, *Molecular Biology and Evolution*, 30 (2013), 1015–1031). Phylogenomic analysis of these DGs in chordate genomes provided direct evidence that major diversification has occurred in the ancestor of placental mammals. Mammalian RDDGs have been shown to originate in several steps by independent domestication events and to diversify later by gene duplications. An analysis of syntenic loci has shown that diverse RDDGs and their chromosomal positions were fully established in the ancestor of placental mammals. By an analysis of active Metaviridae lineages in amniotes, we have demonstrated that RDDGs originated from retroelement remains. The chromosomal gene movements of RDDGs were highly dynamic only in the ancestor of placental mammals. During the domestication process, *de novo* acquisition of regulatory regions is shown to be a prerequisite for the survival of the DGs (Figure 4). The origin and evolution of *de novo* acquired promoters (Figure 5) and untranslated regions in diverse mammalian RDDGs have been explained by a comparative analysis of orthologous gene loci. The findings of this study thus provide a new view on the origin and evolution of the *de novo* acquired promoters, 5'- and 3'-UTRs in diverse mammalian RDDGs. The regulatory wiring of DGs and their rapid fixation in the ancestor of placental mammals have played an important role in the origin of their innovations and adaptations, such

We collaborated intensively with colleagues from the Department of Biology, the Biotechnical faculty (BF), UL, in the determination of the mode of action of lipid membrane pore-forming proteins from the mushroom *Pleurotus ostreatus*. With structural identification we participated at the conclusion that for the formation of the pore in membranes, rich in cholesterol and sphingomyelin, pleurotolysin B requires the presence of another protein, ostreolysin A (K. Ota et al., *Biochimie*, 95 (2013), 1855–1864). During the isolation of ostreolysin A from the mushroom an additional protein co-eluted. Structural analysis of this protein revealed the first example of a protein consisting of hemopexin repeats in yeast (K. Ota et al., *Biochim. Biophys. Acta - Proteins and Proteomics*, 1834 (2013), 1468–1473). Together with the same group we also prepared a review paper on the use of pore-forming toxins for the sensing and labelling of membrane microdomains (M. Skočaj et al., *Current Medicinal Chemistry*, 20 (2013), 491–501). A very important joint project with colleagues from the BF was dedicated to developing an original approach against bacterial infections. In the evolution of the resistance of bacteria against antibiotics their SOS system is of a crucial importance. The key role in the bacterial SOS response is played by a complex formed between a single-stranded DNA (ssDNA) and two bacterial proteins, RecA and LexA. Based on the experimental data we built a tri-dimensional model of the complex ssDNA–RecA–LexA (Figure 6), which will enable the targeted design of substances to prevent the development of bacterial resistance to antibiotics. We published our results in a very prominent journal (L. Kovačič et al., *Nucleic Acids Research*, 41 (2013), 9901–9910).

Together with our partners from the University Medical Centre Ljubljana, Department of Rheumatology, we improved the isolation protocol of two proteins from human serum that are vital for the diagnostics of the antiphospholipid syndrome (A. Artenjak et al., *Clinical and Developmental Immunology*, in press).

With colleagues from the Institute of Biochemistry, the Medical Faculty, UL, we demonstrated that the recombinant human erythropoietin (EPO) modulates the expression of some genes and stimulates the proliferation of the MCF-7 breast-cancer cells. We did not, however, observe a correlation between the level of expression of different EPO receptor isoforms and the invasiveness of the breast-cancer cells (N. Trošt et al., *Radiology and Oncology*, 47 (2013), 382–389).

We helped colleagues from the National Institute of Chemistry and the Centre of Excellence for Polymer Materials and Technologies (CE PoliMaT) with the microbiological testing of the antibacterial activity of macroporous polyurethane hybrid material with a high content of zinc and showed that it is highly bactericidal (G. Ambrožič et al., *Materials Research Bulletin*, 48 (2013), 1428–1434).

Some outstanding publications in the past year

1. Kokošar, J., Kordiš D. (2013): Genesis and regulatory wiring of retroelement-derived domesticated genes: a phylogenomic perspective. *Mol. Biol. Evol.* 30, 1015–1031
2. Kovačič, L., Paulič, N., Leonardi, A., Hodnik, V., Anderluh, G., Podlesek, Z., Žgur-Bertok, D., Križaj, I., Butala, M. (2013): Structural insight into LexA–RecA* interaction. *Nucleic Acids Res.* 41, 9901–9910
3. Pucer, A., Brglez, V., Payre, C., Pungercar, J., Lambeau, G., Petan, T. (2013): Group X secreted phospholipase A₂ induces lipid droplet formation and prolongs breast cancer cell survival. *Mol. Cancer* 12, e111
4. Sajevec, T., Leonardi, A., Kovačič, L., Lang Balija, M., Kurtović, T., Pungercar, J., Halassy, B., Trampuš-Bakija, A., Križaj, I. (2013): VaH3, one of the principal hemorrhage-inducing factors in *Vipera ammodytes ammodytes* venom, is a homodimeric P-IIIc metalloproteinase. *Biochimie* 95, 1158–1170
5. Vardjan, N., Mattiazzi, M., Rowan, E.G., Križaj, I., Petrovič, U., Petan, T. (2013): Neurotoxic phospholipase A₂ toxicity model – an insight from mammalian cells. *Commun. Integr. Biol.* 6, e23600

Awards and appointments

1. Award of the Slovenian Research Agency for an exceptional scientific achievement in 2012 in Slovenia in the field of Biochemistry and Molecular Biology (*Conus consors* snail venom proteomics unveils functions, pathways and novel families involved in its venomous system)

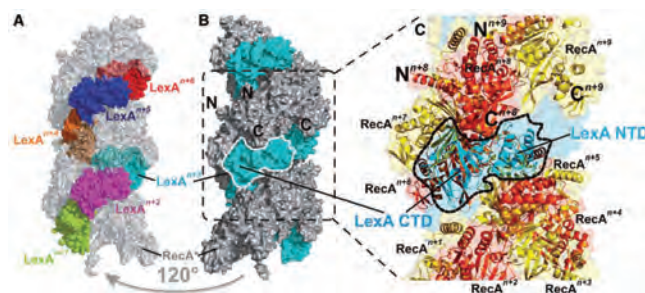


Figure 6: Model of the LexA–RecA* three-dimensional structure. (A) Six intact LexA monomers (spherical representation, each in a different colour) are docked on two turns of the RecA* (shown as grey transparent surface). (B) LexA–RecA* complex rotated by 120° around vertical axis relative to the view in (A). LexA monomers are presented in cyan and RecA in grey. The N- and C-termini of the two RecA monomers are marked. One of the LexA monomers is encircled by a broken line. (C) Detailed view of the LexA–RecA* complex. The same LexA monomer as in (B) is encircled. LexA C- and N-terminal domains (CTD and NTD) are indicated. Nine successive RecA monomers (presented in yellow and orange) surround one monomer of LexA. Seven RecA protomers out of nine constitute the LexA-interaction interface. The figure is reproduced from L. Kovačič et al., *Nucleic Acids Research*, 41 (2013), 9901–9910.

INTERNATIONAL PROJECTS

1. Structural Explanation of the High Increase in Enzymatic Activity of Secreted Phospholipases A₂ in Complex with Calmodulin by High Resolution NMR
Utrecht University, Faculty of Science
Dr. Lidija Kovačič
2. Towards the Identification of N-type sPLA₂ Receptors
Slovenian Research Agency
Prof. Jože Pungerčar
3. Financial support for the preparation of the project application within the 7th Framework Programme
European Commission
Prof. Igor Križaj

RESEARCH PROGRAM

1. Toxins and Biomembranes
Prof. Igor Križaj

R&D GRANTS AND CONTRACTS

1. Apoptotic Effects of Alkylpyridinium Compounds on Lung Adenocarcinoma Cells
Prof. Igor Križaj
2. Molecular Description of Lipid Membrane Changes in Disease
Prof. Igor Križaj
3. Discovering Innovative Drugs for Regulation of Haemostasis by Venomics of the *Vipera ammodytes* Snake
Prof. Igor Križaj
4. Pathogenomics and Systems Biology of New Virulence Factors in Pathogenic Bacteria
Prof. Dušan Kordiš
5. Structural Explanation of the High Increase in Enzymatic Activity of Secreted Phospholipases A₂ in Complex with Calmodulin by High Resolution NMR
Dr. Lidija Kovačič

NEW CONTRACT

1. Analyses
Central Technological Library at the University of Ljubljana
Prof. Igor Križaj

VISITOR FROM ABROAD

1. Dr. Gerard Lambeau, Institute de Pharmacologie Moleculaire et Cellulaire, Universite Nice, Sophia Antipolis, France, 11.-19. 9. 2013

STAFF

Researchers

1. Asst. Prof. Dušan Kordiš
2. **Prof. Igor Križaj, Head**
3. Dr. Adrijana Leonardi
4. Prof. Uroš Petrovič
5. Prof. Jože Pungerčar

Postdoctoral associates

6. Dr. Janez Kokošar
7. *Dr. Lidija Kovačič, on postdoctoral leave since 01.10.13*
8. Dr. Mojca Mattiazzi Ušaj
9. Asst. Prof. Toni Petan
10. Dr. Jernej Šribar

Postgraduates

11. Vesna Brglez, B. Sc.
12. Minca Ferlin, B. Sc.
13. Jernej Oberčkal, B. Sc.
14. *Anja Pucer, B. Sc., left 01.10.13*
15. *Tamara Sajevec, B. Sc., left 01.10.13*

Technical officer

16. Mojca Brložnik, B. Sc.

Technical and administrative staff

17. Igor Koprivec
18. Darja Žunič Kotar

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Gabriela Ambrožič, Jernej Šribar, Srečo D. Škapin, Majda Žigon, Zorica Crnjak Oreš, "An antibacterial macroporous polyurethane hybrid material with a high content of zinc ions: a template to uniform ZnO nanoparticles", *Mater. res. bull.*, vol. 48, no. 4, pp. 1428-1434, 2013.
2. Iztok Dogša, Mojca Brložnik, David Stopar, Ines Mandič-Mulec, "Exopolymer diversity and the role of levan in *Bacillus subtilis* biofilms", *PLoS one*, vol. 8, iss. 4, pp. 1-10, e62044, 2013.
3. Zala Jenko Pražnikar, Toni Petan, Jože Pungerčar, "Ammydotoxins efficiently release arachidonic acid and induce apoptosis in a motoneuronal cell line in an enzymatic activity-dependent manner", *Neurotoxicology (Park Forest South)*, vol. 35, pp. 91-100, 2013.
4. Janez Kokošar, Dušan Kordiš, "Genesis and regulatory wiring of retroelement-derived domesticated genes: a phylogenomic perspective", *Molecular biology and evolution*, vol. 30, issue 5, pp. 1015-1031, 2013.
5. Lidija Kovačič, Nejc Paulič, Adrijana Leonardi, Vesna Hodnik, Gregor Anderluh, Zdravko Podlesek, Darja Žgur-Bertok, Igor Križaj, Matej Butala, "Structural insight into LexARecA interaction", *Nucleic acids res.*, vol. 42, issue 21, pp. 9901-9910, 2013.
6. Nataša Lindič, Maruška Budič, Toni Petan, Binyamin A. Knisbacher, Erez Y. Levanon, Nika Lovšin, "Differential inhibition of LINE1 and LINE2 retrotransposition by vertebrate AID/APOBEC proteins", *Retrovirology*, vol. 10, art. no. 156, pp. 1-16, 2013.
7. Katja Ota, Adrijana Leonardi, Miha Mikelj, Matej Skočaj, Therese Wohlschlager, Markus Künzler, Markus Aebi, Mojca Narat, Igor Križaj, Gregor Anderluh, Kristina Sepčič, Peter Maček, "Membrane cholesterol and sphingomyelin, and ostreolysin A are obligatory for pore-formation by a MACPF/CDC-like pore-forming protein, pleurotolysin B", *Biochimie (Paris)*, vol. 95, iss. 10, pp. 1855-1864, 2013.
8. Katja Ota, Miha Mikelj, Tadeja Papler, Adrijana Leonardi, Igor Križaj, Peter Maček, "Ostreopexin: a hemopexin fold protein from the oyster mushroom, *Pleurotus ostreatus*", *Biochimica et biophysica acta, Proteins and proteomics*, vol. 1834, no. 8, pp. 1468-1473, 2013.
9. Anja Pucer, Vesna Brglez, Christine Payré, Jože Pungerčar, Gérard Lambeau, Toni Petan, "Group X secreted phospholipase A2 induces lipid droplet formation and prolongs breast cancer cell survival", *Mol. Cancer*, vol. 12, art. no. 111, pp. 1-23, 2013.
10. Tamara Sajevec, Adrijana Leonardi, Lidija Kovačič, Maja Lang Balija, Tihana Kurtović, Jože Pungerčar, Beata Halassy, Alenka Trampuš-Bakija, Igor Križaj, "VaH3, one of the principal hemorrhagins in *Vipera ammodytes ammodytes* venom, is a homodimeric P-IIIc metalloproteinase", *Biochimie (Paris)*, vol. 95, issue 6, pp. 1158-1170, 2013.

11. Erin Styles, Ji-Young Youn, Mojca Mattiazzi, Brenda J. Andrews, "Functional genomics in the study of yeast cell polarity: moving in the right direction", *Philosophical Transactions, Biological Sciences*, vol. 368, no. 1629, pp. 20130118-1-20130118-11, 2013.
12. Nina Trošt, Tina Stepišnik, Sabina Berne, Anja Pucer, Toni Petan, Radovan Komel, Nataša Debeljak, "Recombinant human erythropoietin alters gene expression and stimulates proliferation of MCF-7 breast cancer cells", In: Articles from 7th Conference of experimental and translational oncology, April, 20-24, 2013, Portorož, *Radiol. Oncol.*, vol. 47, no. 4, pp. 382-389, 2013.
13. Nina Vardjan, Mojca Mattiazzi, Edward G. Rowan, Igor Križaj, Uroš Petrovič, Toni Petan, "Neurotoxic phospholipase A₂ toxicity model: an insight from mammalian cells", *Communicative & integrative biology*, vol. 6, no. 3, pp. 23600-1-23600-3, 2013.
2. Matej Skočaj, Biserka Bakrač, Igor Križaj, Peter Maček, Gregor Anderluh, Kristina Sepčić, "The sensing of membrane microdomains based on pore-forming toxins", *Curr. med. chem.*, vol. 20, no. 4, pp. 491-501, 2013.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Toni Petan, Petra Prijatelj, Jože Pungerčar, "Protein engineering in structure-function studies of viper's venom secreted phospholipases A₂", In: *Genetic manipulation of DNA and protein - examples from current research*, David Figurski, ed., Rijeka, InTech, cop. 2013, pp. 107-132.

REVIEW ARTICLE

1. Vasja Progar, Uroš Petrovič, "Vpliv parametrov sekvenciranja naslednje generacije na zanesljivost rezultatov v metagenomskih študijah", *Informativa medica slovenica*, vol. 18, no. 1/2, pp. 1-8, 2013.

MENTORING

1. Janez Kokošar, *Comparative genomics and phenotypic impact of novel retrotransposon-derived genes in placental mammals: doctoral dissertation*, Ljubljana, 2013 (mentor Dušan Kordiš).

DEPARTMENT OF BIOTECHNOLOGY

B-3

At the Department of Biotechnology we investigate biological molecules of microbiological, fungal, plant and animal origin using modern biotechnological methods. We would like to apply them for diagnostic and therapeutic purposes in human and veterinary medicine, for plant protection, the preparation of high-quality and safe food and for the protection of the environment, contributing to an improvement in people's health and of the environment in which we live. Our research work is focused on the processes of cancer progression and immune response, neurodegenerative processes, the biology of fungi, plant stress response and on the search for new biotechnological approaches and products.



Head:
Prof. Janko Kos

In 2013 the field of research on fungal protease inhibitors broadened our knowledge on trypsin inhibitors from mushrooms. We have shown that stable trypsin inhibitors are present in different edible and poisonous mushrooms. We have isolated and biochemically characterized trypsin inhibitors from the parasol mushroom (*Macrolepiota procera*), death cap (*Amanita phalloides*), and the honey fungus (*Armillaria mellea*). Their properties resemble those of the previously characterized trypsin inhibitors cnispin and cospin from the mushrooms clouded agaric (*Clitocybe nebularis*) and the inky cap (*Coprinopsis cinerea*). They show exceptional stability, as even after heating to 100°C they still retain their inhibitory activity. Furthermore, we have previously reported that inhibitors of cysteine proteases, macrocypins from the parasol mushroom (*Macrolepiota procera*), exhibit a negative effect on the growth and development of Colorado potato beetle larvae, and in 2013 we have described their mechanism of action in this process. The exceptional feature of these fungal protease inhibitors is that macrocypins do not elicit an adaptive response in the guts of Colorado potato beetle larvae to increased levels of protease inhibitors in food, which has been routinely shown for protease inhibitors from different animal and plant sources. Therefore, our results have been published in the *Journal of Agricultural and Food Chemistry*, which is the top journal in the subject category of Agriculture.

Macrocypins from the parasol mushroom (*Macrolepiota procera*), exhibit a negative effect on the growth and development of Colorado potato beetle larvae and do not elicit an adaptive response.

In the field of glycobiology, we continued with studies on different lectins from the mushrooms clouded agaric (*Clitocybe nebularis*) and the parasol mushroom (*Macrolepiota procera*). In addition to a biochemical characterization, where recombinant versions prepared in bacterial expression system were used, we focused on an analysis of their effects on different cell lines with an emphasis on immune cells. Additionally, we have in the field of lectin research performed an applicative project for an industrial partner.

In cooperation with the National Institute of Biology we have explored mushrooms as a novel source of proteins with antibacterial activity. We used a phytopathogenic Gram negative bacterium *Ralstonia solanacearum* as a model, which is the causative agent of a quarantine brown rot disease of potatoes and other economically important plants, including tomato, ginger, tobacco and banana plants. From the screening of 150 aqueous extracts from mushrooms collected in Slovenian forests, we have detected antibacterial activity in eleven. Three of those – from mushrooms soap-scented toadstool (*Tricholoma saponaceum*), velvet bolete (*Suillus variegatus*) and trooping funnel (*Clitocybe geotropa*) – caused slower progression of disease symptoms and lower disease occurrence in both tomato and potato plants. We described the preparation and content of extracts from selected mushroom species that showed antibacterial activity against the economically important bacterial phytopathogenic crop pest in a patent application “Composition and method for plant protection”, filed at the Slovenian Intellectual Property Office (P-201300349).



Figure 1: Testing of mushroom extracts on phytopathogenic Gram negative bacterium *Ralstonia solanacearum*

We contributed a chapter entitled Medicinal Mushrooms, which represents the first complete presentation of medicinal mushrooms in the Slovenian literature, to a book published by the Slovenian Pharmaceutical Society “Contemporary Phytotherapy”, which is the first Slovenian book on medicinal plants, which is based only on scientifically supported research and clinical studies and is entirely the work of Slovenian authors. The book is an important source of information for specialists and students, but also for

Cysteine protease cathepsin X regulates neuroprotective function of gamma enolase.



Figure 2: A: Honey mushroom (*Armillaria mellea*) as a source of trypsin inhibitors

the users of medicinal plants who are interested in more detailed, scientifically supported data.

The continuing study of the response of the common bean (*Phaseolus vulgaris*) to drought has been directed to the aminopeptidases previously shown to be involved. Their activities in leaves change under the influence of stress, although to different extents. Interestingly, the pattern of these changes depends on the age and/or the position of the leaves. Two of these aminopeptidases have been classified as serine proteases, and others are dependent on metal ions, although they are also inhibited by serine protease inhibitors. Two of the latter enzymes hydrolyse Ala-AMC and Lys-AMC and are expressed in leaves and seedlings. The activity of the enzyme expressed in leaves is modulated by metal ions in the nanomolar/picomolar range. Mn^{2+} is the most likely candidate for the physiological activation of the enzyme activity of "leaf" aminopeptidase. In addition, a serine endopeptidase and several aminopeptidases, already shown to be involved in the response to complete desiccation of the model resurrection plant *Ramonda serbica*, have been characterised.

An important part of our research was focused on the role of proteases and protease inhibitors in malignant, immune and neurodegenerative processes. Within the programme group we determined molecular mechanisms that imply the role of cysteine protease cathepsin X in neurodegenerative and malignant processes. We also continued studies on the role of the cysteine protease inhibitor cystatin F in the regulation of dendritic cells and natural killer cells (NKs). In the latter we demonstrated that the mechanism leading to its monomeric active form in endosomes/lysosomes, significantly affects the activity of the cathepsins C and H and consequently the cytotoxicity of NK cells. The activity of cystatin F seems to be crucial for the split energy of NK cells, a mechanism caused by tumour cells to avoid their destruction.

We continued our research on the role of FUS protein in the frontotemporal dementia (FTD) and amyotrophic lateral sclerosis (ALS). We reported that overexpression of the wildtype FUS protein in a mouse model leads to symptoms similar to ALS. The resulting mouse model will enable more detailed studies of the mechanisms of the disease, as well as the testing of new therapeutic approaches. The results were published in *Acta Neuropathologica*. In a study published in *Human Molecular Genetics* we found that the disease associated mutations in FUS prevent its entry into the cell nucleus, giving rise to the accumulation and aggregation of the protein in the cytoplasm. Upon oxidative stress, the cytoplasmic FUS accumulates in stress granules, which are possible precursors of aggregates observed in the neurons of patients with FUS-positive ALS or FTD. We reported on the further characterization of FUS co-localisation with transporting in neural tissues of patients for ALS and FTD. We focused on RNA-protein interactions of long RNA repeats, which are associated with ALS and FTD. We have reported the discovery of the interaction between GGGGCC repeat with hnRNPH protein and confirmed this interaction in the nervous tissue of patients, which indicates the importance of the interaction in ALS and FTD.

We have continued with the research aimed at improving the surface display on *Lactococcus lactis*, as well as some other lactic acid bacteria, with the goal to improve their biotechnological applicability. We have finished and published the results of the study on the improvement of the carrier protein BmpA, which enabled the covalent attachment of recombinant proteins to the surface of *Lactococcus lactis*. We improved the surface display of recombinant proteins, bound in a non-covalent manner, with the use of peptidoglycan-binding LysM repeats. The efficacy of such a surface display we tested in ten different species from the genus *Lactobacillus* and noticed large differences among various species. We have confirmed the relationship between the efficiency of the surface display and the content of lipoteichoic acid in the bacterial cell wall and demonstrated that the surface display in *Lactococcus lactis* is improved by limiting the production of lipoteichoic acid.

In collaboration with the Institute of Biotechnology of the ASCR in Prague (Czech Republic) we began the development of specific low-molecular

Overexpression of the protein FUS is associated with amyotrophic lateral sclerosis.

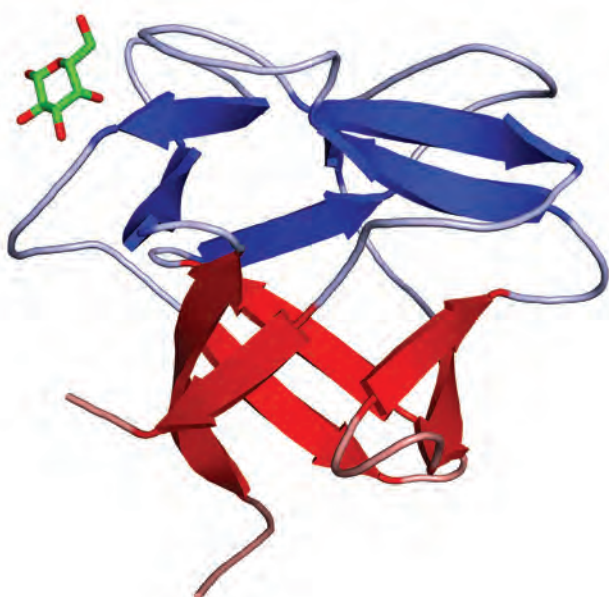


Figure 3: The structure of lectin Mpl

protein BmpA, which enabled the covalent attachment of recombinant proteins to the surface of *Lactococcus lactis*. We improved the surface display of recombinant proteins, bound in a non-covalent manner, with the use of peptidoglycan-binding LysM repeats. The efficacy of such a surface display we tested in ten different species from the genus *Lactobacillus* and noticed large differences among various species. We have confirmed the relationship between the efficiency of the surface display and the content of lipoteichoic acid in the bacterial cell wall and demonstrated that the surface display in *Lactococcus lactis* is improved by limiting the production of lipoteichoic acid.

A member of the department was a recipient of the Zois award for outstanding achievements in the field of proteolytic enzymes and their regulation.

binding molecules based on the albumin-binding domain scaffold and directed against the B subunit of the shiga toxin.

We have developed a new method for the simple detection of biliverdin, heme degradation product, in body-fluid samples. A determination of biliverdin is especially important in veterinary diagnostics. The method is based on the specific interaction of biliverdin with an infrared fluorescent protein. The latter requires biliverdin as a cofactor and exhibits infrared fluorescence only after biliverdin binding. The suggested method has acceptable accuracy and precision and, in contrast to the existing methods, enables the parallel testing of a large number of samples. Additionally, the use of infrared fluorescent protein directly from bacterial lysate makes the method cost effective.

The results of the research work at the Department of Biotechnology in 2013 were published in 39 scientific papers in journals with an impact factor, in 12 book chapters, and in 5 published papers from scientific conferences. The Head of Department, prof. Janko Kos, was a recipient of the Zois award for outstanding achievements on the field of proteolytic enzymes and their regulation, awarded by the Government of the Republic of Slovenia. The authors of the book *Contemporary Phytotherapy* received a prestigious award in the field of promotion and popularisation of science "Prometheus for excellence in scientific communication" for 2013 by The Slovenian Science Foundation. The members of the department were also very active in pedagogical work as lecturers and mentors to students preparing diploma and doctoral theses at the University of Ljubljana, University of Maribor and Jožef Stefan Postgraduate School.

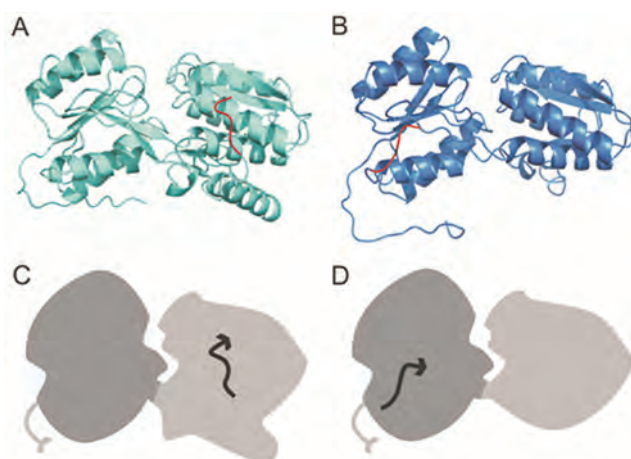


Figure 4: Model of BmpA protein and its shortened variant Bmp1, which has significantly improved ability for surface display on the bacterium *Lactococcus lactis*.

Some outstanding publications in the past year

1. Mitchel, J., McGoldrick, P., Vance, C., Hortobagyi, T., Sreedharan, J., Rogelj, B., Tudor, Elizabeth L., Smith, Bradley N., Klasen, C., Miller, Christopher C. J., CoopeR, Jonathan D., Greensmith, L., SHAW, Christopher E.: Overexpression of human wild-type FUS causes progressive motor neuron degeneration in an age- and dose-dependent fashion. *Acta Neuropathologica*, 2013, 125, 2, 273–288
2. Šmid, I., Gruden, K., Buh Gašparič, M., Koruza, K., Petek, M., Pohleven, J., Brzin, J., Kos, J., Žel, J., Sabotič, J.: Inhibition of the growth of Colorado potato beetle larvae by macrocypins, protease inhibitors from the parasol mushroom. *Journal of agricultural and food chemistry*, ISSN 0021-8561, [in press] 2013, 38 pgs., doi: 10.1021/jf403615f
3. Pišlar, A., Glavan, G., Obermajer, N., Živin, M., Schliebs, R., Kos, J.: Neuroprotective role of [gamma]-enolase in microglia in a mouse model of Alzheimer's disease is regulated by cathepsin X. *Aging cell*, 2013, 12, iss. 4, 604–614

Awards and appointments

1. Janko Kos: Zois Award for the highest scientific achievements in the field of proteolytic enzymes and their regulation, Maribor, the Government of the Republic of Slovenia

Organization of conferences, congresses and meetings

1. Organization of the annual meeting of co-workers of the research program "Pharmaceutical biotechnology: knowledge for health" from the Department of Biotechnology at the Josef Stefan Institute and the Chair of Pharmaceutical Biology at the Faculty of Pharmacy of the University of Ljubljana, Slovenia, 21. 11. 2013

Patent granted

1. Ida Istinič, Meti Buh Gašparič, Jerica Sabotič, Kristina Gruden, Jože Brzin, Jana Žel, Use of macrocypins as pesticidal agents, SI23835 (A), Urad RS za intelektualno lastnino, 28.2.2013.
2. Borut Štrukelj, Samo Kreft, Damjan Janeš, Nina Kočever Glavač, Eva Tavčar, Marko Slokar, Ante Zaloker, Refined liquid antioxidant extract from the bark of fir tree and process for its production, SI23867 (A), Urad RS za intelektualno lastnino, 29.3.2013.
3. Borut Štrukelj, Samo Kreft, Damjan Janeš, Nina Kočever Glavač, Eva Tavčar, Marko Slokar, Ante Zaloker, Viktor Grilc, Ivan Mirt, Željko Cerovečki, Complex antioxidant extract from the bark of fir tree with cyclodextrins, SI23862 (A), Urad RS za intelektualno lastnino, 29.3.2013.

INTERNATIONAL PROJECTS

1. ALSTransfid; Stress TDP43 - Does Stress Induced Reduction of Translation Fidelity Play a Role in ALS/FTLD?
Fondation Thierry Latran
Prof. Boris Rogelj
2. The Role of Cysteine Proteases and their Inhibitors in Split Anergy of Natural Killer Cells to Tumor Cells
Slovenian Research Agency
Prof. Janko Kos

RESEARCH PROGRAM

1. Pharmaceutical Biotechnology: Knowledge for Health
Prof. Janko Kos

R&D GRANTS AND CONTRACTS

1. Response to Water Stress in Common Bean (*Phaseolus vulgaris* L.): Proteomic Analysis and QTL Mapping
Prof. Janko Kos

2. Transport and RNA Binding of TDP-43 and FUS - Implications for ALS/FTLD Spectrum of Neurodegenerative Disease
Prof. Boris Rogelj
3. Dysregulation of TDP-43 Expression in Amyotrophic Lateral Sclerosis and Frontotemporal Lobar Degeneration
Prof. Boris Rogelj
4. Nitroxoline and Its Derivatives as New Antitumour Drugs
Dr. Jerica Sabotič
5. Post-Transcriptional Regulatory Networks in Neurodegenerative Diseases
Prof. Boris Rogelj
6. Inhibitors of Cysteine Carboxypeptidases as Regulators of Autoimmune and Neurodegenerative Processes
Prof. Janko Kos
7. Protein Engineering of Recombinant Probiotic Lactic Acid Bacteria for Treatment of Irritative Bowel Disease
Prof. Borut Štrukelj

NEW CONTRACTS

1. Development and Application of New Methods of Genetic Engineering of Probiotic Lactic Acid Bacteria
Labena, d. o. o.
Asst. Prof. Aleš Berlec

VISITORS FROM ABROAD

1. Prof. Jawett Anahid, University of California, Los Angeles, USA, 20.-24. 4. 2013

STAFF

Researchers

1. Prof. Kristina Gruden*
2. **Prof. Janko Kos***, Head
3. Prof. Boris Rogelj
4. Prof. Borut Štrukelj*

Postdoctoral associates

5. Asst. Prof. Aleš Berlec
6. Dr. Anja Kovanda
7. Dr. Milica Perišić Nanut
8. *Dr. Jure Pohleven, left 01.10.13*
9. Dr. Katja Rebolj
10. Dr. Jerica Sabotič

11. Dr. Sabina Vatovec

Postgraduates

12. Simona Darovic, B. Sc.
13. Katja Lužar, B. Sc.
14. Maja Štalekar, B. Sc.
15. Simon Žurga, B. Sc.

Technical and administrative staff

16. Darja Žunič Kotar

Note:

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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Aleksandar Aničin, Nina Gale, Alojz Šmid, Janko Kos, Primož Strojan, "Expression of stefin A is of prognostic significance in squamous cell carcinoma of the head and neck", *Eur. arch. oto-rhino-laryngol.*, vol. 270, iss. 12, pp. 3143-3151, 2013.
2. Nevena Arsenović-Ranin, Mirjana Nacka Alekšič, Jasmina Djikić, Milica Perišić, Duško Kosec, Ivan Pilipović, Zorica Stojić Vukanić, Gordana Leposavić, "Thymocyte apoptosis and proliferation modeling during rat thymic involution is influenced by ovarian hormones in a thymocyte subset-specific manner", *Acta vet. (Beogr.)*, vol. 63, no. 1, pp. 3-21, 2013.
3. Nevena Arsenović-Ranin, Milica Perišić, Biljana Bufan, Zorica Stojić Vukanić, Ivan Pilipović, Duško Kosec, Gordana Leposavić, "Ovarian hormone withdrawal in prepubertal developmental stage does not prevent thymic involution in rats", *Exp. biol. medicine (Maywood, N.J.: Print)*, vol. 238, no. 6, pp. 641-657, 2013.
4. Aleš Berlec, Tadej Malovrh, Petra Zadravec, Andrej Steyer, Matjaž Ravnikar, Jerica Sabotič, Mateja Poljšak-Prijatelj, Borut Štrukelj, "Expression of a hepatitis A virus antigen in *Lactococcus lactis* and *Escherichia coli* and evaluation of its immunogenicity", *Appl. microbiol. biotechnol.*, vol. 97, iss. 10, pp. 4333-4342, 2013.
5. Annette Block, Frédéric Debode, Lutz Grohmann, Julie Hulin, Isabel Taverniers, Linda Kluga, Elodie Barbau-Piednoir, Sylvia Broeders, Ingrid Huber, Marc Bulcke, Petra Heinze, Gilbert Berben, Ulrich Busch, Nancy Roosens, Erik Janssen, Jana Žel, Kristina Gruden, Dany Morisset, "The GMOseek matrix: a decision support tool for optimizing the detection of genetically modified plants", *BMC bioinformatics*, vol. 14, pp. [1-14], 256, 2013.
6. Maruška Budič, Jerica Sabotič, Vladimir Meglič, Janko Kos, Marjetka Kidrič, "Characterization of two novel subtilases from common bean (*Phaseolus vulgaris* L.) and their responses to drought", *Plant physiol. biochem. (Paris)*, vol. 62, pp. 79-87, 2013.
7. Meti Buh Gašparič, Metka Lenassi, Cene Gostinčar, Ana Rotter, Ana Plemenitaš, Nina Gunde-Cimerman, Kristina Gruden, Jana Žel, "Insertion of a specific fungal 3'-phosphoadenosine-5'-phosphatase motif into a plant homologue improves halotolerance and drought tolerance of plants", *PLoS one*, vol. 8, iss. 12, Dec. 2013.
8. David Dobnik, Špela Baebler, Polona Kogovšek, Maruša Pompe Novak, Dejan Štebih, Gabriela Panter, Nikolaja Janež, Dany Morisset, Jana Žel, Kristina Gruden, "β-1,3-glucanase class III promotes spread of PVY^{NTN} and improves *in planta* protein production", *Plant biotechnol. reports*, vol. 7, iss. 4, pp. 547-555, 2013.
9. Zala Jevnikar, Matija Rojnik, Polona Jamnik, Bojan Doljak, Urša Pečar Fonovič, Janko Kos, "Cathepsin H mediates the processing of talin and

- regulates migration of prostate cancer cells", *J Biol Chem*, vol. 288, pp. 2201-2209, 2013.
10. Benjamin Kirm, Vasilka Magdevska, Miha Tome, Marinka Horvat, Katarina Karničar, Marko Petek, Robert Vidmar, Špela Baebler, Polona Jamnik, Štefan Fujs, Jaka Horvat, Marko Fonovič, Boris Turk, Kristina Gruden, Hrvoje Petković, Gregor Kosec, "SACE_5599, a putative regulatory protein, is involved in morphological differentiation and erythromycin production in *Saccharopolyspora erythraea*", *Microb Cell Fact*, vol. 12, pp. 126-1-126-15, 2013.
 11. Andreja Nataša Kopitar, Miha Skvarč, Bojan Tepeš, Janko Kos, Alojz Ihan, "Helicobacter pylori susceptible/resistant to antibiotic eradication therapy differ in the maturation and activation of dendritic cells", *Helicobacter (Camb. Mass.)*, vol. 18, iss. 6, pp. 444-453, Dec. 2013.
 12. Slavko Kralj, Matija Rojnik, Janko Kos, Darko Makovec, "Targeting EGFR-overexpressed A431 cells with EGF-labeled silica-coated magnetic nanoparticles", *J. nanopart. res.*, vol. 15, no. 5, pp.1666-1-1666-11, 2013.
 13. Laura Langohr, Vid Podpečan, Marko Petek, Igor Mozetič, Kristina Gruden, Nada Lavrač, Hannu Toivonen, "Contrasting subgroup discovery", *Comput. j.*, vol. 56, no. 3, pp. 289-303, sep. 2013.
 14. 20, Youn-Bok Lee, Maja Štalekar, Jernej Ule, Boris Rogelj, "Hexanucleotide repeats in ALS/FTD form length-dependent RNA foci, sequester RNA binding proteins, and are neurotoxic", *Cell reports*, vol. 5, no. 5, pp. 1178-1186, 2013.
 15. Špela Magister, Janko Kos, "Cystatins in immune system", *Journal of cancer*, vol. 4, no. 1, pp. 45-56, 2013.
 16. Jacqueline C. Mitchell *et al.* (13 authors), "Overexpression of human wild-type FUS causes progressive motor neuron degeneration in an age- and dose-dependent fashion", *Acta Neuropathol*, vol. 125, issue 2, pp. 273-288, 2013.
 17. Dany Morisset, Dejan Štebih, Mojca Milavec, Kristina Gruden, Jana Žel, "Quantitative analysis of food and feed samples with droplet digital PCR", *PLoS one*, vol. 8, issue 5, pp. e62583-1-e62583-9, 2013.
 18. Urša Pečar Fonovič, Zala Jevnikar, Janko Kos, "Cathepsin S generates soluble CX3CL1 (fractalkine) in vascular smooth muscle cells", *Biol Chem*, vol. 394, iss. 10, pp. 1349-1352, 2013.
 19. Urša Pečar Fonovič, Zala Jevnikar, Matija Rojnik, Bojan Doljak, Marko Fonovič, Polona Jamnik, Janko Kos, "Profilin 1 as a target for cathepsin X activity in tumor cells", *PLoS one*, vol. 8, iss. 1, pp. 1-9, e53918, 2013.
 20. Milica Perišić, Zorica Stojić Vukanić, Ivan Pilipović, Duško Kosec, Mirjana Nacka Alekšič, Jasmina Djikić, Nevena Arsenović-Ranin, Gordana Leposavič, "Role of ovarian hormones in T-cell homeostasis: from the thymus to the periphery", *Immunobiology (1979)*, vol. 218, no. 3, pp. 353-367, 2013.
 21. Ivan Pilipović, Katarina Radojevič, Duško Kosec, Milica Perišić, Zorica Stojić Vukanić, Nevena Arsenović-Ranin, Gordana Leposavič, "Gonadal hormone dependent developmental plasticity of catecholamine: β_2 -adrenoceptor signaling complex in male rat thymus: putative implications for thymopoiesis", *J. neuroimmunol.*, vol. 265, issue 1-2, pp. 20-35, 2013.
 22. Anja Pišlar, Gordana Glavan, Nataša Obermajer, Marko Živin, Reinhard Schliebs, Janko Kos, "Neuroprotective role of γ -enolase in microglia in a mouse model of Alzheimer's disease is regulated by cathepsin X", *Aging cell*, vol. 12, iss. 4, pp. 604-614, 2013.
 23. Anja Pišlar, Janko Kos, "C-terminal peptide of γ -enolase impairs amyloid- β -induced apoptosis through p75^{NTR} signaling", *Neuromol. med.*, vol. 15, iss. 3, pp. 623-635, 2013.
 24. Anja Pišlar, Janko Kos, "Cysteine cathepsins in neurological disorders", *Mol. neurobiol.*, vol. iss., 14 pp., 2013.
 25. Anja Pišlar, Nace Zidar, Danijel Kikelj, Janko Kos, "Cathepsin X promotes 6-hydroxydopamine-induced apoptosis of PC12 and SH-SY5Y cells", *Neuropharmacology*, vol., no., pp., 2013.
 26. Nina Prezeli, Petra Nikolič, Kristina Gruden, Maja Ravninar, Marina Dermastia, "Spatiotemporal distribution of flavescence dorée phytoplasma in grapevine", *Plant Pathol.*, vol. 62, no. 4, pp. 760-766, 2013.
 27. Miha Skvarč, David Štubljar, Andreja Nataša Kopitar, Samo Jeverica, Bojan Tepeš, Janko Kos, Alojz Ihan, "Inhibition of cathepsin X enzyme influences the immune response of THP-1 cells and dendritic cells infected with *Helicobacter pylori*", *Radiol. oncol. (Ljublj.)*, vol. 47, no. 3, pp. 258-265, V, sep. 2013.
 28. Bradley N. Smith *et al.* (46 authors), "The C9orf72 expansion mutation is a common cause of ALS + l-FTD in Europe and has a single founder", *Eur J Hum Genet*, vol. 21, issue 1, pp. 102-108, 2013.
 29. Adaleta Softić, Lejla Begić, A. Halilbašić, Tjaša Vižin, Janko Kos, "The predictive value of cystatin C in monitoring of B non-Hodgkin lymphomas: relation to biochemical and clinical parameters", *ISRN oncol.*, vol. 2013, art. ID 752792, 2013.
 30. Izidor Sosič, Bojana Mirković, Katharina Arenz, Bogdan Štefane, Janko Kos, Stanislav Gobec, "Development of new cathepsin B inhibitors: combining bioisosteric replacements and structure-based design to explore the structure-activity relationships of nitroxoline derivatives", *J. med. chem.*, vol. 56, no. 2, pp. 521-533, 2013.
 31. Zorica Stojić Vukanić, Biljana Bufan, Nevena Arsenović-Ranin, Duško Kosec, Ivan Pilipović, Milica Perišić, Gordana Leposavič, "Aging affects AO rat splenic conventional dendritic cell subset composition, cytokine synthesis and T-helper polarizing capacity", *Biogerontology*, vol. 14, no. 4, pp. 443-459, 2013.
 32. Ida Šmid, Kristina Gruden, Meti Buh Gašparič, Katarina Koruza, Marko Petek, Jure Pohleven, Jože Brzin, Janko Kos, Jana Žel, Jerica Sabotič, "Inhibition of the growth of Colorado potato beetle larvae by macrocyclic protease inhibitors from the parasol mushroom", *J. agric. food chem.*, vol. 61, issue 51, pp. 12499-12509, 2013.
 33. Caroline Vance *et al.* (13 authors), "ALS mutant FUS disrupts nuclear localization and sequesters wild-type FUS within cytoplasmic stress granules", *Hum Mol Genet*, vol. 22, issue 13, pp. 2676-2688, 2013.
 34. Irma Virant-Klun, Thomas Skutella, Matjaž Hren, Kristina Gruden, Branko Cvjetičanin, Andrej Vogler, Jasna Šinkovec, "Isolation of Small SSEA-4-Positive Putative Stem Cells from the Ovarian Surface Epithelium of Adult Human Ovaries by Two Different Methods", *Biomed Res Int*, vol. 2013, 15 pp., 2013.
 35. Miha Vodnik, Peter Molek, Borut Štrukelj, Mojca Lunder, "Peptides binding to the hunger hormone ghrelin", *Horm. Metab. Res.*, vol. 45, no. 5, pp. 372-377, 2013.
 36. Marta Zapotoczna, Zala Jevnikar, Helen Miajlovič, Janko Kos, Timothy J. Foster, "Iron regulated surface determinant B (IsdB) promotes *Staphylococcus aureus* adherence to and internalization by non-phagocytic human cells", *Cell. microbiol.*, vol. 15, no. 6, pp. 1026-1041, 2013.

REVIEW ARTICLE

1. Aleš Berlec, "Sodobna biološka in rastlinska zdravila za zdravljenje astme", *Farm. vestn.*, vol. 64, no. 2, pp. 137-142, maj 2013.
2. Aleš Berlec, Borut Štrukelj, "Current state and recent advances in biopharmaceutical production in *Escherichia coli*, yeasts and mammalian cells", *J. ind. microbiol. biotech.*, vol. 40, no. 3-4, pp. 257-274, 2013.
3. Andreja Emeršič, Zvezdan Pirtošek, Mateja Štempelj, Borut Štrukelj, "Zdravljenje Alzheimerjeve bolezni", *Farm. vestn.*, vol. 64, no. 3, pp. 202-207, avg. 2013.
4. Borut Štrukelj, "Pljučne bolezni in cigarete: ali trošarina pokrije zdravljenje?", *Farm. vestn.*, vol. 64, no. 2, pp. 146-150, maj 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Jana Erjavec, Tanja Dreo, Jože Brzin, Jerica Sabotič, Maja Ravninar, "Naravne protimikrobne snovi in mikroorganizmi kot sredstva za varstvo rastlin", In: *Zbornik predavanj in referatov 11. slovenskega posvetovanja o varstvu rastlin z mednarodno udeležbo (in Okroglo mize o zmanjšanju tveganja zaradi rabe FFS v okviru projekta CropSustain)*, Bled, 5.-6. marec 2013, Stanislav Trdan, ed., Jože Maček, ed., Ljubljana, Društvo za varstvo rastlin Slovenije, = Plant Protection Society of Slovenia, 2013, pp. 132-137.
2. Jurica Levatič, Živa Ramšak, Tjaša Stare, Dragi Kocev, Kristina Gruden, Sašo Džeroski, "Gene function prediction for *Solanum tuberosum* from time-series gene expression data", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 158-167.
3. Dragana Miljković, Vid Podpečan, Tjaša Stare, Igor Mozetič, Kristina Gruden, Nada Lavrač, "Incremental revision of biological networks from texts", In: *Proceedings, IWBBIO 2013*, International Work-Conference on Bioinformatics and Biomedical Engineering, March 18-20, 2013, Granada, [Sl. l. s. n.], 2013, pp. 1-9.
4. Vid Podpečan, Dragana Miljković, Marko Petek, Tjaša Stare, Kristina Gruden, Igor Mozetič, Nada Lavrač, "Integrating semantic transcriptomic data analysis and knowledge extraction from biological literature", In: *Proceedings*, 2013 IEEE International Conference on Bioinformatics and Biomedicine Workshops BIBM 2013, Shanghai, China, December 18-21, 2013, Danvers, Institute of Electrical and Electronics Engineers, 2013, pp. 477-480.

- Katja Rebolj, Ema Žagar, Katja Ota, Valerija Vežočanik, Kristina Sepčić, Peter Maček, "Analiza lipidnih veziklov in lipidnih kapljic s pretočnim sistemom z asimetričnim prečnim pretokom", In: *Slovenski kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, pp. 1-9.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

- Marko Bohanec *et al.* (13 authors), "The Co-Extra decision support system: a model-based integration of project results", In: *Genetically modified and non-genetically modified food supply chains: co-existence and traceability*, Yves Bertheau, ed., Chichester, Blackwell, cop. 2013, pp. 459-489.
- Marc Bulcke *et al.* (17 authors), "The modular approach in GMO quality control and enforcement support systems", In: *Genetically modified and non-genetically modified food supply chains: co-existence and traceability*, Yves Bertheau, ed., Chichester, Blackwell, cop. 2013, pp. 293-306.
- Kristina Gruden *et al.* (30 authors), "Reliability and cost of GMO detection", In: *Genetically modified and non-genetically modified food supply chains: co-existence and traceability*, Yves Bertheau, ed., Chichester, Blackwell, cop. 2013, pp. 307-332.
- Arne Holst-Jensen *et al.* (28 authors), "Towards detection of unknown GMOs", In: *Genetically modified and non-genetically modified food supply chains: co-existence and traceability*, Yves Bertheau, ed., Chichester, Blackwell, cop. 2013, pp. 367-382.
- Rade Injac, Matevž Prijatelj, Borut Štrukelj, "Fullerenol nanoparticles: toxicity and antioxidant activity", In: *Oxidative stress and nanotechnology: methods and protocols*, (Methods in Molecular Biology, vol. 1028), Donald Armstrong, ed., Dhruba J. Bharali, ed., New York, Humana Press, 2013, pp. 75-100.
- Nataša Mehle, Petra Nikolić, Kristina Gruden, Maja Ravnikar, Marina Dermastia, "Real-time PCR for specific detection of three phytoplasmas from the apple proliferation group", In: *Phytoplasma: methods and protocols*, (Methods in Molecular Biology, vol. 938), (Springer Protocols), Matthew Dickinson, ed., Jennifer Hodgetts, ed., New York, Humana Press, 2013, pp. 269-281.
- Nataša Mehle, Nina Prezelj, Matjaž Hren, Jana Boben, Kristina Gruden, Maja Ravnikar, Marina Dermastia, "A real-time PCR detection system for the bois noir and flavescence dorée phytoplasmas and quantification of the target DNA", In: *Phytoplasma: methods and protocols*, (Methods in Molecular Biology, vol. 938), (Springer Protocols), Matthew Dickinson, ed., Jennifer Hodgetts, ed., New York, Humana Press, 2013, pp. 253-268.
- Maria Pla *et al.* (26 authors), "New multiplexing tools for reliable GMO detection", In: *Genetically modified and non-genetically modified food supply chains: co-existence and traceability*, Yves Bertheau, ed., Chichester, Blackwell, cop. 2013, pp. 333-366.
- Isabel Taverniers *et al.* (15 authors), "Harmonised reference genes and PCR assays for GMO quantification", In: *Genetically modified and non-genetically modified food supply chains: co-existence and traceability*, Yves Bertheau, ed., Chichester, Blackwell, cop. 2013, pp. 273-292.

PATENT

- Ida Istinič, Meti Buh Gašparič, Jerica Sabotič, Kristina Gruden, Jože Brzin, Jana Žel, *Use of macrocyclic pesticides as pesticidal agents*, SI23835 (A), Urad RS za intelektualno lastnino, 28.2.2013.
- Borut Štrukelj, Samo Kreft, Damjan Janeš, Nina Kočevar Glavač, Eva Tavčar, Marko Slokar, Ante Zaloker, *Refined liquid antioxidant extract from the bark of fir tree and process for its production*, SI23867 (A), Urad RS za intelektualno lastnino, 29.3.2013.
- Borut Štrukelj, Samo Kreft, Damjan Janeš, Nina Kočevar Glavač, Eva Tavčar, Marko Slokar, Ante Zaloker, Viktor Grilc, Ivan Mirt, Željko Cerovečki, *Complex antioxidant extract from the bark of fir tree with cyclodextrins*, SI23862 (A), Urad RS za intelektualno lastnino, 29.3.2013.

MENTORING

- Mitja Mahnič, *Genomics and proteomics tools for identification of factors that influence the formation of "unclassical" inclusion bodies in Escherichia coli*: doctoral dissertation, Ljubljana, 2013 (mentor Kristina Gruden).
- Anja Pišlar, *Regulation of neurotrophic activity of γ -enolase by proteolytic enzymes and role in neurodegenerative diseases*: doctoral dissertation, Ljubljana, 2013 (mentor Janko Kos; co-mentor Nataša Obermajer).
- Ana Torkar, *Development of selective cathepsin L inhibitors*: doctoral dissertation, Ljubljana, 2013 (mentor Janko Kos; co-mentor Tamara Lah Turnšek).
- Jana Vojvoda, *Annual dynamics and diversity of ammonia-oxidizing archaea and bacteria in coastal waters of the Gulf of Trieste*: doctoral dissertation, Ljubljana, 2013 (mentor Valentina Turk; co-mentor Kristina Gruden).
- Janja Božič, *Influence of probiotics on metabolism and absorption of atorvastatin, ampicillin, propranolol, pentazocine, paracetamol and ticlopidine*: master's thesis, Ljubljana, 2013 (mentor Borut Štrukelj; co-mentor Aleš Berlec).
- Barbara Breznik, *Establishment and characterization of in vitro tumour invasion models using the cell line U-87*: master's thesis, Ljubljana, 2013 (mentor Janko Kos; co-mentor Bojana Mirkovič).
- Maruša Gašperlin, *Development of oligonucleotides for the development of a new method for psoriasis treatment using antisense DNA technology*: master's thesis, Ljubljana, 2013 (mentor Borut Štrukelj; co-mentor Matjaž Ravnikar).
- Laura Gómez Cuadrado, *Development of FRET technology of protein-protein interactions by using protease inhibitor system*: master's thesis, Ljubljana, 2013 (mentor Borut Štrukelj).
- Irenej Jerič, *Development of new method for oligonucleotide insertion into mammalian cells by using chemoporation*: master's thesis, Ljubljana, 2013 (mentor Borut Štrukelj; co-mentor Matjaž Ravnikar).
- Neža Kikelj, *Verification of the capability of analytical methods to determine changes in monoclonal antibody exposed to stress conditions*: master's thesis, Ljubljana, 2013 (mentor Janko Kos; co-mentor Tadej Čepeljnik).
- Eva Koprivec Furlan, *Investigation of organoprotective effects of oral and intraperitoneal application of fullerenol in vivo during doxorubicin therapy on small pigs*: master's thesis, Ljubljana, 2013 (mentor Borut Štrukelj; co-mentor Rade Injac).

DEPARTMENT OF ENVIRONMENTAL SCIENCES

O-2

Activities in the Department of Environmental Sciences are diverse and varied as the environment itself. They are multidisciplinary, from different natural sciences to even social sciences, in particular, chemical, physical, geological and biological, which define our environment, society, and human activities. With our research work we want to clarify the relationship between natural processes and human activities, and the influence of these activities on human health and the environment. The scope of our studies, educational and technological aspects of research and development are thematically described in chapters: Environmental analytical chemistry, Biological and geochemical cycles, Environment, nutrition, health, Environmental monitoring, Clean technologies and waste management, Risk and environmental impact assessment. The research summaries and outline of the activities of the research groups and centres within the Department of Environmental Sciences is presented in these chapters.

Environmental analytical chemistry

In the field of the analysis of organic compounds we devoted most of our research to studying the fate of pharmaceutical and personal care product residues in environmental and wastewater samples, and sediments. Compounds of interest included representative nonsteroidal anti-inflammatory drugs, lipid regulators, hormones, tranquilisers, antidepressants, cytostatics, and industrial compounds that produce an endocrine disrupting effect. To improve the sampling, we developed our own passive-sampling method for selected pharmaceuticals and have applied it to surface and ground waters. Currently, the method is being optimised.

In the area of cytostatic research within the framework of FP7 CytoThreat, we developed a series of analytical procedures for determining 5-fluorouracil, capecitabine, cyclophosphamide, ifosfamide, methotrexate, imatinib, vincristin and etoposide and their commercially available metabolites in waste and environmental water samples. We also investigated their presence in hospital and municipal wastewaters and in receiving surface waters. Through our work we show the presence of detectable quantities of these compounds in wastewaters from hospitals where cancer therapies are being conducted. In addition, fluorouracil was present in wastewater-treatment-plant influent. None of the studied cytostatics were detected in the wastewater-treatment-plant effluent and their receiving waters. We also studied the bio- and photodegradation of fluorouracil, capecitabine, methotrexate, imatinib, vincristin and etoposide and our group is the first to identify several novel transformation products formed during these processes. We also organised an interlaboratory study of the determination of selected cytostatics in surface and waste waters and the statistical evaluation of the results is currently being carried out in collaboration with CSIC, Barcelona, Spain.

In the field of endocrine-disrupting compounds, we researched industrial chemicals and personal care-product ingredients, including bisphenol A, triclosan, parabens and benzophenones. For bisphenol A, triclosan, and parabens we modified an analytical procedure developed for human biomonitoring and applied it to wastewaters. We are currently performing pilot-scale biodegradation studies. We also participated in an interlaboratory round-robin study for the determination of selected pharmaceuticals and hormone disruptors in drinking water. For benzophenones, which are structurally a common denominator for UV filters and selected pharmaceuticals and their transformation products, we developed analytical procedures that allowed us to study aqueous and sediment samples. In addition, we studied the cycling of these compounds in the environment with an emphasis on their photodegradation under natural and simulated sunlight.

The Center for Mass Spectrometry in the O2 department participates in the research and application projects of many research groups at the JSI, Slovenian universities, the National Institute of Chemistry, Krka and Lek pharmaceutical companies and other users. For the mass spectrometric measurements of organic compounds we used a high-resolution tandem mass spectrometer Q-ToF Premier, equipped with electrospray ionization source (ESI), which is also coupled with an ultra performance liquid chromatograph (UPLC). This instrument in LC-MS mode was used, for example, for the analysis, occurrence, degradation and transformation of Fluorouracil cytostatic in the environment. The Steroid toxicity and detoxification in fungi were measured with GC-MS. With tandem mass spectrometry MS-MS the structures of phototoxic fagopyrins from buckwheat and the composition of the silver fir (*Abies alba*) bark extract Abigenol and its antioxidant activity were determined.

The use of stable isotopes was introduced to better understand the Neolithic pottery assemblage from the Mala Triglavca and Resnik sites was analysed to obtain insights into vessel use and husbandry practices. Total lipid extracts



Head:

Prof. Milena Horvat



Figure 1: Extreme weather conditions such as flooding, snowfalls and fires have an important influence on environmental processes Floods and NPP Krško, Krško 2012

High snow and transmission lines, Kočevje region 2012/2013

Drought, fires and transmission lines, Primorska region 2013

of the pottery samples were subjected to gas chromatography (GC), gas chromatography-mass spectrometry (GC-MS), gas chromatography-combustion-isotope ratio mass spectrometry (GC-C-IRMS) and soft ionisation electrospray mass spectrometric techniques ESI Q-TOF MS and ESI Q-TOF MS/MS. The results show that some vessels were used for cooking ruminant meat, while in other traces of mixed non-ruminant and ruminant meat or plants and animal meat cooking were identified. Some vessels were used for milk processing. With this research we enter into the recent discussion on the occurrence, development and expansion of dairy economies in Europe in early prehistory.

We have also introduced a method for determining the content and isotopic composition of fatty acids in milk and cheese. The method is used for determining the geographical origin and authenticity of milk and milk products.

In the area of radiochemical methods wet digestion procedures for the dissolution of biological samples in the determination of ^{210}Po were compared. Classical wet ashing over a gas flame with acids on a long-necked Kjeldahl flask, digestion with acids in an Erlenmeyer flask and microwave digestion in a Teflon vessel at temperatures up to 200 °C were investigated. The results obtained showed that the activity concentrations of ^{210}Po found in the samples analysed were comparable for all the procedures used.

In the area of chemical metrology the certification of trace elements in candidate Certified Reference Materials for the EU, JRC, Institute for Reference Materials and measurements (IRMM): (i) Determination of trace elements in Lu-foil and (ii) Determination of Au mass fraction in aluminium matrix ERM-EB530A, ERM-EB530B and ERM-EB530C. It is also important to mention our collaboration in stability studies for CRMs prepared by IRMM (ERM-EC680k, ERM-EC681k, ERM-EC590, ERM-EC591, ERM-EF411 and ERM-CE278k). In addition, a series of CCQM Key Intercomparisons was also organized. Based on the excellent performance a series of CMC (*Calibration Measurement Capability*) claims is also planned in 2014, which will be later entered in the KCDB (*Key Comparisons Data Base*). Furthermore, ordinarily participation in inter-laboratory comparison studies organised by IAEA, ISPRA, WEPAL and other reference laboratories is our mission, as well as their organization.

In the framework of the EMRP project ENV02 dealing with Hg traceability issues in car-exhaust measurements the reactivity and stability of various Hg compounds were investigated to support further research in adsorption mechanisms and analytical methods related to clean technology.

Biological and geochemical cycles

Organic geochemical biomarkers combined with a compound-specific isotopic composition were used to determine the sources and transformation pathways of organic matter in the anoxic eutrophic alpine Lake Bled. The use of compound-specific carbon-isotope analyses of sedimentary lipids in recent anoxic sediments indicated that, despite the fact that the biomarker analysis revealed mostly plankton and terrestrial sources of lipids, an important part of the sedimentary lipids, especially sterols, should be autochthonous of anaerobic microbial origin. A stable isotope approach was further used to identify the sources of polycyclic aromatic hydrocarbons (PAHs) in sediments. It was found that retene (Re) and perylene (Per) are both mainly of natural origin in Zaka Bay, while in anoxic sediments, the value of $\delta^{13}\text{C}$ determined at a depth of 12-14 cm in the 1950s indicated that Re was of pyrolytic origin. The stream Solznik drains the partially coniferous Lake Bled watershed, which could be the source of Re in Zaka Bay sediments. The distribution of $\delta^{13}\text{C}$ values of other individual PAH showed that the PAH input to lake sediments was of pyrolytic origin, likely dominated by coal and wood burning. The influence of PAH originating from vehicular emissions could be seen at the sediment depth corresponding to the period 1953-1961.

We continued the studies of carbon mass balance and carbon cycle on the Slovenian territory. The sources of dissolved inorganic carbon in surface- and groundwater in karstic areas were studied. It was found that approximately the same fractions of biogenic (deriving from the decomposition of organic matter and soil CO_2) and geogenic (deriving from the weathering of carbonate rocks) CO_2 are drained from the area by the rivers. In karstic rivers supersaturated with respect to carbonate, tufa precipitation is one of the efficient mechanisms of carbon fixation; however, in Slovenia, the Krka river is the only large stream with tufa barriers. The precipitation rate of river carbonate was estimated and was found to be critically dependent on the turbulence, temperature and the presence of biofilm at the river bottom, although the degassing of CO_2 into it occurs throughout the year along the entire river course. Our research performed in the Gulf of Trieste confirmed that the Gulf is a sink of CO_2 throughout the year. The river plumes of particulate matter and dissolved nutrients play an important role in carbon cycling by direct inputs of terrigenous carbon, enhancing increased biological activity of the Gulf through the supply of riverine

nutrients. In cooperation with the Velenje Coal Mine, the sources of coalbed gases were determined, based upon regular analyses of composition and stable isotope composition of gases in relation to the geomechanical conditions at the excavation fields Preloge and Pesje.

In the framework of the international project coordinated by the International Atomic Energy Agency, the spatial variability of stable isotope composition of snow cover and its influence on the surface runoff and groundwater were studied, in collaboration with colleagues from other Slovenian (University of Ljubljana, Forestry Institute, Anton Melik Geographical Institute, Environment Agency of Slovenia) and Russian (Lomonosov University, Moscow) research institutions.

In collaboration with Croatian colleagues from Ruder Bošković Institute (Zagreb) and the Institute for Oceanography and Fisheries (Split), geochemical and isotopic analyses were used to study nutrient and contaminant transfer and nutrition sources of filtering organisms along the Adriatic Coast on the case of different cultured and wild populations of mussels and invasive serpulids (*Ficopomatus enigmaticus*).

In the framework of the GMOS project further measurements of Hg in air, precipitation, and water continued. In 2013 the measurements of Hg in air using research aircraft were made in the western part of Slovenia.

From the area of applicative research the potential of the re-use of dredged mud from the Port of Koper in civil applications was investigated together with co-workers from the National Building Institute in Ljubljana.

The partitioning of natural radionuclides in sediments and streams affected by the waste piles of a former uranium mine and mill located at Žirovski vrh, Slovenia, was performed by applying a sequential extraction procedure. The results definitely showed that the total activity concentrations at sites downstream of the influence of the waste piles were higher than at sites upstream of the piles. This difference was geographically very limited to a distance of about 5 km downstream. The fractionation of radionuclides upstream and downstream of the area of influence of the waste piles did not appear to be significantly altered.

Measurements of ^{226}Ra activity concentrations are often used to estimate supported levels of ^{210}Pb for purposes of geochronology. However, the implicit assumption that the supported ^{210}Pb and ^{226}Ra are in secular equilibrium may not always be true because of the migration of an intermediate product, i.e., gaseous ^{222}Rn . As a consequence, supported ^{210}Pb activity concentration might be lower than the measured ^{226}Ra value, which was the case in a core collected from the South Adriatic Pit. Therefore, we proposed a new approach to improve the determination of supported ^{210}Pb , which is based on the correction of ^{226}Ra activity concentrations using the average ($^{210}\text{Pb}/^{226}\text{Ra}$) activity ratio in deeper sediment layers.

The activity concentrations of ^{238}U , ^{230}Th , ^{226}Ra and ^{210}Pb were determined in soil and grass samples collected from sites at the uranium mill-tailings waste pile. Soil-to-plant transfer factors were determined and the potential use of grass as a monitor of radionuclide migration from the waste pile was evaluated. It was found that grass was not suitable for monitoring ^{230}Th and ^{210}Pb migration, but it has potential in predicting ^{238}U and ^{226}Ra migration.

Within the EU 7FP BlackSeaHazNet project, continuous monitoring of radon in soil gas as well as of hydro-meteorological parameters were underway. The obtained time-series of data have been analysed using statistical machine-learning techniques (regression-decision trees and artificial neural networks), aimed at studying the influence of tectonic and seismic activities on radon transport mechanisms in soil.

Environment, nutrition, health

Knowing the pharmacokinetics of chemotherapeutics in serum contribute to the optimization of cancer treatment. Conjoint liquid chromatography (CLC) was introduced for the simultaneous two-dimensional separation of ionic forms of metal-based chemotherapeutics from the portions bound to serum proteins. The method is based on assembling CIM Protein G and CIM DEAE disks in a single housing, forming a CLC monolithic column. On the first disk chemotherapeutic bound to immunoglobulin G is separated, while on the second disk the unbound form of the chemotherapeutic is separated from the portion bound to albumin and transferrin. In combination with UV and inductively coupled plasma mass spectrometry (ICP-MS) detection of the kinetics of binding of cisplatin, carboplatin and oxaliplatin to serum proteins was investigated in spiked human serum. The CLC method was introduced to the field of metallomics for the first time.

Selenoproteins and MT mRNA expression were studied in APL patients during arsenic trioxide treatment. The gene expression of six metallothionein (MT) (sub) isoforms, namely MT2a, MT1 (a, e, f, x) and MT3, together with four selenoproteins was followed by qPCR. The weak influence on MTs and suppressed gene expression of seleno-

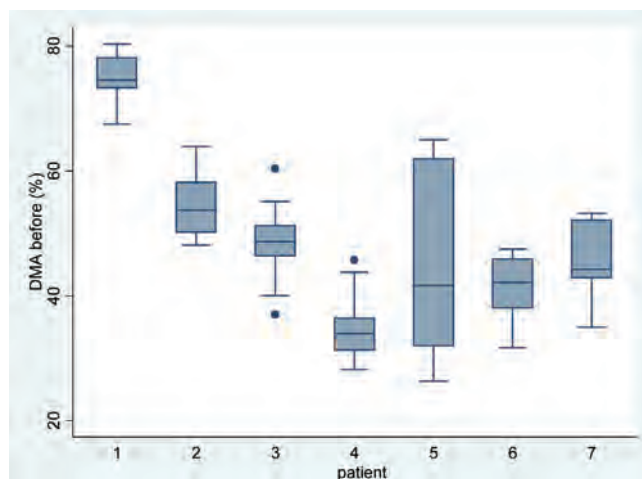


Figure 2: Acute promyelocytic leukemia patients treated by As_2O_3 are in need for the individualization of the therapy and its monitoring. The inter-personal variability of the biotransformation was clearly seen by the excretion of dimethylarsinic acid (DMA) in urine collected daily before the As_2O_3 injection for seven patients.

proteins were observed after exposure to therapeutic concentrations of arsenic (up to 2 μM As in blood serum). The results related to MTs are interesting regarding chemoresistance during cancer treatment and as resistance against the toxic effects of metals present in food and water or in the working environment (occupational exposure), while the effects on selenoproteins is important in relation to the treatment efficiency and the side effects of therapy. Simultaneously, methylation of arsenic and selenium excretion were followed.

Monolithic chromatography in combination with ICP-MS and time-of-flight mass spectrometry (Q-TOF-MS) detection was successfully applied in the investigation of nickel speciations in tea infusions. In addition, a study was performed on a determination of the total nickel concentrations in different foodstuffs. These data are important for subjects allergic to nickel, who should avoid foods with elevated nickel concentrations.

The enriched isotopic solutions of $^{50}\text{Cr(VI)}$ and $^{53}\text{Cr(III)}$ were applied as tracers in the speciation of Cr in environmental and food samples. The data revealed that toxic Cr(VI) cannot exist in foodstuffs of plant origin like tea infusions and bread samples. The isotopic $^{50}\text{Cr(VI)}$ and $^{53}\text{Cr(III)}$ solutions were also used to follow the transformation of chromium species (oxidation - reduction) during the extraction of chromium from soil samples and in the optimization of the extraction procedure. Accurate quantification of exchangeable Cr(VI) in soil samples was further performed by the isotope dilution (ID)-ICP-MS technique.

In collaboration with the Catholic University of Louvain the uptake of arsenic in hydroponically grown rice exposed to iron and arsenic was studied. Along rice roots the iron hydroxides precipitate and include arsenic as well as reducing arsenic uptake and toxicity. Together with Swedish scientists the influence of arsenic contaminated rice on the human health of an exposed population in Bengal (India) was evaluated. We also studied the arsenic speciation in the larvae of aquatic insects in pools with high, but localized, arsenic levels along streams in Sweden. The larvae contained high

levels of inorganic arsenic, but fish who feed on them had very low arsenic levels. Most probably the fish live in a much bigger territory than the larvae and feed on mostly uncontaminated larvae from cleaner parts of the stream.

To investigate the impact of Se on Tartary buckwheat (*Fagopyrum tataricum* Gaertn.) plants, the plant foliage was sprayed with 10 mg Se(VI) L⁻¹ at the beginning of flowering. The Se was effectively assimilated by the plants and taken into the seeds, where its concentration was more than double that in untreated plants. The seeds were collected and sown to obtain the progeny of these Se-treated plants. To assess the physiological characteristics of control plants and these Se-treated progeny plants, the estimated respiratory potential via electron transport system (ETS) activity and the photochemical efficiency of photosystem II were measured. Three weeks after germination, the Se-treated progeny plants showed higher ETS activity compared to the controls. Through weeks 4 and 5, this high ETS activity approximately halved, and the difference in ETS activity seen at 3 weeks was lost. On the other hand, at week 4, the potential photochemical efficiency was higher in the Se-treated progeny plants than in the controls. In adult plants, the leaves' dry mass was significantly greater in the Se-treated progeny plants than in the controls. This study demonstrates the impact of Se in tartary buckwheat on the progeny plants of Se sprayed plants.

Selenium and selenium species were studied in shellfish in the Slovenian market. In one of the studies we included two main fish species that represent the most commonly consumed fresh fish in Slovenia; trout (*Oncorhynchus mykiss*) and seabass (*Dicentrarchus labrax*) from different locations (Slovenia, Italy, Greece) and environments (fish grown in fish farms and wild fish from their natural environment). Our aim was to compare the differences in selenium and its species amount between fish from farms and fish in their natural environment.

Stable isotope composition ($^2\text{H}/^1\text{H}$, $^{13}\text{C}/^{12}\text{C}$, $^{15}\text{N}/^{14}\text{N}$, $^{18}\text{O}/^{16}\text{O}$), elemental composition and selected physical parameters (fruit mass, antioxidant activity, content of ascorbic acid and total phenols) were used to differentiate Slovenian apples according to their geographical origin. The database on Slovenian milk was established, containing isotopic parameters, elemental and fatty acid composition.

In radon (^{222}Rn) research we focused on the air in dwellings, karst caves and soil. A relationship was sought between the concentrations of radon and carbon dioxide in different yearly seasons at different points in the Postojna Cave. Correlation was usually good, with correlation coefficient R^2 reaching 0.85, except in the closed and feebly ventilated Pisani rov corridor in which levels of both gases were by an order of magnitude higher, showing $R^2=0.91$ in spring and $R^2=0.61$ in summer. This difference has been explained by an additional radon source in summer, when the ventilation is minimal because the outside air temperature is higher than in the cave. In this cave also effect of the nano aerosol concentration and particles size distribution (5–1100 nm range) on the formation of radon short-lived products (^{218}Po , ^{214}Pb , ^{214}Bi and ^{214}Po) and their attachment to aerosol particles was investigated.

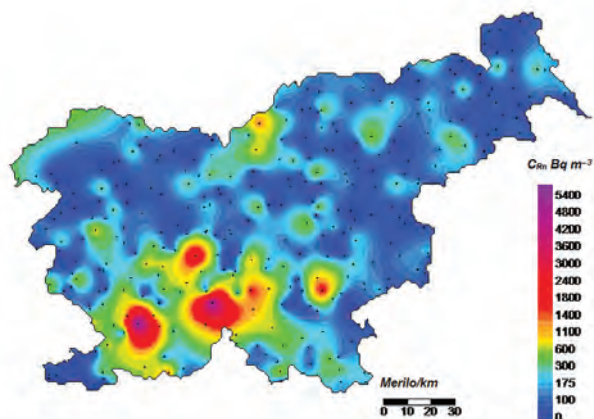


Figure 3: Spatial distribution of radon activity concentration in 400 dwellings all over Slovenia in 2013

The aerosol characteristics were influenced by the weather conditions and tourist visits. Our special focus has been product atoms associated with the <50 nm particles, the crucial datum in radon dosimetry.

In a systematic survey, co-funded through a SCOPES project, solid-state nuclear track detectors were exposed twice for half a year, to measure the activity concentrations of radon and thoron (^{220}Rn) and their short-lived products in one dwelling in each of 400 squares of 7 km \times 7 km size covering the entire country. The average annual effective doses will be calculated and the exposure of the general population to radon and thoron will be evaluated. As in previous surveys, the majority of higher levels have been found over carbonate bedrock, and very often that occurred also in new buildings. In a bilateral cooperation with Serbia, complex environmental analyses of indoor air in several selected dwellings in both Slovenia and Serbia have been performed, comprising carbon dioxide, radon and its products (with an emphasis on <50 nm), thoron, nano aerosol (number concentration and particle size distribution), and positive and negative ions (< nm).

Within the EU 7FP CITI-SENSE project (Development of sensor-based Citizens' Observatory Community for improving quality of life in cities) pilot study was designed within which air quality will be monitored at selected outdoor locations, as well as indoor in schools and on the participatory principle during movement of people wearing mobile units.

In the frame of the EU 7FP ArcRisk project (Impacts on health in the Arctic and Europe owing to climate-induced changes in contaminant cycling) study on the exposure of European population to mercury was performed. The results of the study were published in the Environmental toxicology and chemistry journal as an review article entitled "Mercury exposure and effects in Europe.

Environmental technologies

In collaboration with BF, University of Ljubljana, we investigated the influence of pharmaceutical diazepam on the structure and phylogenetic composition of the bacterial community in activated sludge from a series of pilot wastewater treatment plants. Based on our findings, only a small proportion of the bacterial consortia are responsible for the increased removal efficiency of diazepam in the bioreactors. The high diversity of bacteria in the reactors with the addition of diazepam indicates that the studied pharmaceutical is nontoxic to the bacteria in activated sludge at the concentration applied (100 $\mu\text{g/L}$). We also researched the biodegradation potential of proteobacterial and fungal laccases, i.e., enzymes that have the potential to degrade compounds with aromatic, particularly phenolic structures. Batch biodegradation experiments with laccases Bacillus and ThioLacc indicated their high potential for the biodegradation of bisphenol A, whereas the enzymes were less efficient in degrading ibuprofen, clofibric acid, ketoprofen, diazepam, carbamazepine and diclofenac.

In collaboration with FS and FGG, University of Ljubljana we investigated the potential of cavitation as a wastewater-treatment technology. Hydrodynamic cavitation was for the first time evaluated for the simultaneous removal of clofibric acid, ibuprofen, naproxen, ketoprofen, carbamazepine and diclofenac in complex WW matrices.

In collaboration with the Department of Inorganic Chemistry and Technology we continued our research on cost-effective methodologies for the removal of mercury in flue gasses by an oxidation method in flue-gas desulfurization plants. Mathematical models were introduced and used for the simulation of aqueous Hg chemistry. Mercury behaviour in solid samples at higher temperatures was also studied as part of the initial experiments for the removal of Hg from gases at higher temperatures.

Risk and environmental impact assessment

The most demanding and comprehensive work in 2013 was the Sustainability appraisal of energy policy development of Slovenia by 2030 and beyond as a basis for strategic orientation and decision-making. The focus was on possible further nuclear-energy development. In the framework of consultancy work for GEN energija d.o.o., a revised report on damages caused by Fukushima NPP has been made, while for the industrial partner TTK Srpenica a concept of risk reduction has been provided. Work on international projects covered activities related to the Coordinated Research Project "Techno-economic Evaluation of Options for Adapting Nuclear and Other Energy Infrastructure to Long-term Climate Change and Extreme Weather", which is coordinated by the IAEA.

The radiological risk to wildlife around the former uranium mine and mill located at Žirovski vrh, Slovenia was assessed by the ERICA Tool and found to be negligible. Activity concentrations in bovine milk from the area of Žirovski vrh were comparable to the reference location, except for uranium, where the content was higher. The combined annual effective dose for adults consuming milk from the Žirovski vrh area is $13.0 \pm 1.7 \mu\text{Sv a}^{-1}$.

Based on the technical documentation prepared among the others by co-workers from O2, the "Minamata Convention on Mercury" was adopted under the auspices of the UNEP organisation. The Convention is an international treaty designed to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. Our contribution resulted in two chapters of the report dealing with global releases and the cycling of mercury.

Environmental Monitoring

In collaboration with Chemical Office of the Republic of Slovenia, University Medical centre Ljubljana, regional institutes of Public Health, regional hospitals and health we continued national human biomonitoring. We analyse toxic chemicals including toxic metals (cadmium, lead, mercury) and persistent organic pollutant including dioxins, pesticides, PCBs, polybrominated flame retardant in human blood, urine and maternal milk. Results will be used for the assessment of the burden of the Slovenian population with these environmental pollutants. The regular monitoring programme comprised measurements for updating the database on the isotopic composition of Slovenian wines in accordance with EU regulations, and the isotopic composition of precipitation in Slovenia.

In collaboration with the Environmental Agency of the Republic of Slovenia the monitoring of organotin compounds in surface and sea water was continued in 2012.

The monitoring of natural radionuclides within the influential area of the former uranium mine and mill at Žirovski vrh was performed.

We participated in the Off-Site Monitoring of Krško Nuclear power plant by determining the strontium and tritium in environmental samples. Also, we determined the tritium and C-14 in gas effluents from the nuclear power plant. The used methods are accredited by the Slovenian accreditation body (SA LP-090).

In the Department of Environmental Sciences there is also an active mobile chemical laboratory ELME (ecological laboratory with a mobile unit) organized with four intervention teams that are qualified for the fast and effective action in environmental accidents with hazardous materials, determining the parameters of the field, to assess the impact of pollution on the environment and human health and consultation to the neutralisation of the effects of pollution. The chemical mobile unit had four interventions in 2013 because of chemical accidents and environmental pollution.

Some outstanding achievements

1. A method to assign the sources of pollutants such as polycyclic aromatic hydrocarbons (PAH) was developed.
2. An analytical method for the determination of fluorouracil in environmental samples that is more sensitive than existing methods was developed.
3. In collaboration with the National Institute of Biology, the estrogenicity assay ER-Calux[®] to be able to test raw waste-water samples without the need for sample extraction was developed.
4. In collaboration with the Faculty of Mechanical Engineering and the Faculty for Civil Engineering, University of Ljubljana, we evaluated the efficiency of hydrodynamic cavitation for removing micropollutants from wastewaters.
5. For the first time we were able to quantitatively assess the contribution of contaminated sites to the global mercury budget.
6. Conjoint liquid chromatography (CLC) was introduced for the simultaneous two-dimensional separation of ionic forms of metal-based chemotherapeutics from the portions bound to serum.

Some outstanding publications in the past year

1. Gams Petrišič, M., Muri, G., Ogrinc, N.: Source identification of polycyclic aromatic hydrocarbons in Lake Bled (NW Slovenia) sediments using stable carbon isotopes. *Environmental Science & Technology*, ISSN 0013-936X, 2013, vol. 47, issue 3, 1280–1286
2. Martinčič, A., Čemažar, M., Serša, G., Kovač, V., Milačič, R., Ščančar, J.: A novel method for speciation of Pt in human serum incubated with cisplatin, oxaliplatin and carboplatin by conjoint liquid chromatography on monolithic disks with UV and ICP-MS detection. *Talanta*, 2013, 116, 141–148
3. Horvat, M., Chan, L., Sakamoto, M., Faganeli, J. (Eds); Mercury in contaminated sites: identification, characterization, remediation, impact. *Environmental Research*, Special issue, 2013, 125, 214 pgs
4. Štok, M., Smodiš, B., Petrinec, B., Franič, Z.: Correcting for potential ²²²Rn loss in ²¹⁰Pb dating of sediments from the South Adriatic pit. *Quaternary Geochronology*, 2013, 18, 93–98
5. Gregorič, A., Vaupotič, J., Šebela, S.: The role of cave ventilation in governing cave air temperature and radon levels (Postojna Cave, Slovenia). *International Journal of Climatology*, ISSN 0899-8418, 2013, 13
6. Koroušič-Seljak, B., Stibilj, V., Pograjc, L., Fidler Mis, N., Benedik, E.: Food composition databases for effective quality nutritional care. *Food chemistry*, 2013, 130, 495–499
7. Zupanc, M., Kosjek, T., Petkovšek, M., Dular, M., Kompare, B., Širok, B., Stražar, M., Heath, E.: Shear-induced hydrodynamic cavitation as a tool for pharmaceutical micropollutants removal from urban wastewater. *Ultrasonics Sonochemistry*, 2013, 27

Awards and appointments

1. Dr. Tea Zuliani, Prof. Radmila Milačič, Dr. Janez Ščančar: the Poster Prize at the "2013 Winter Conference on Plasma Spectrochemistry" for the presentation "Cr(VI) determination in soil solution by speciated isotope dilution ICP-MS", Krakow, Poland, 10.-15. 2. 2013

Organization of conferences, congresses and meetings

1. Milena Horvat: Workshop: Mercury Environment, health and cultural heritage, Ljubljana, Slovenia, 15.-21. 6. 2013
2. Milena Horvat: Training programme for the determination of trace elements in human biological samples, Ljubljana, Slovenia, 9.-19. 12. 2013

INTERNATIONAL PROJECTS

1. Determination of the isotopic composition of carbon in sugar samples
Prof. Nives Ogrinc
2. Analyses
Prof. Vekoslava Stibilj
3. Provision of Testing Services for Filter Media used in IMS Radionuclide Stations
The Preparatory Commission For The Comprehensive
Prof. Ljudmila Benedik
4. Small Services in the Years from 2007 to 2014
Prof. Milena Horvat
5. Analyses of Metals, TBT and DBT in Sediments, Mussels and Fish
Prof. Janez Ščančar
6. 7FP - iNTeg-Risk; Early Recognition, Monitoring and Integrated Management of
Emerging, New Technology Related Risks
European Commission
Prof. Branko Kontić
7. 7FP - ArcRisk; Arctic Health Risks: Impacts on Health in the Arctic and Europe Owing to
Climate-induced Changes in Contaminant Cycling
European Commission
Prof. Milena Horvat
8. 7FP - GMOS; Global Mercury Observation System
European Commission
Prof. Milena Horvat
9. 7FP - CYTOTREAT; Fate and Effects of Cytostatic Pharmaceuticals in the Environment
and the Identification of Biomarkers for and Improved Risk Assessment on
Environmental Exposure
European Commission
Prof. Ester Heath
10. 7FP - BlackSeaHazNet; Complex Research of Earthquake's Prediction Possibilities,
Seismicity and Climate Change Correlations
European Commission
Prof. Janja Vaupotič
11. 7FP - CITI-SENSE; Development of Sensor-based Citizens' Observatory Community for
Improving Quality of Life in Cities
European Commission
Prof. Milena Horvat
12. 7FP - HEALS; Health and Environment-wide Associations Based on Large Population
Surveys
European Commission
Prof. Milena Horvat
13. PartEmission; EMRP - Emerging Requirements for Measuring Pollutants from
Automotive Exhaust Emissions
Euramet E.v.
Prof. Milena Horvat
14. EMRP; Traceable Measurements for Monitoring Critical Pollutants under the European
Water Framework Directive (WFD-2000/60/EC)
Euramet E.v.
Prof. Radmila Milačič
15. LIFE12 ENV/ - CROME-LIFE; Cross-Mediterranean Environment and Health Network
European Commission
Prof. Milena Horvat
16. Stable Isotope Technique to Assess Human Milk Intake in Infants Living in Areas
Contaminated with Mercury, Lead and Cadmium; Stable Isotope Technique to Assess
Human Milk Intake in Infants Living in Contaminated Areas
IAEA - International Atomic Energy Agency
Prof. Milena Horvat
17. Use of Environmental Isotopes in Investigations of Influence of Snow Melt on Stream
Runoff in the Area of Julian Alps, NW Slovenia
IAEA - International Atomic Energy Agency
Dr. Polona Vreča
18. Assessment of Human Milk Intake in Infants Living in Gold Mining Areas in South West
Nigeria, Using Stable Isotope Techniques
IAEA - International Atomic Energy Agency
Dr. Darja Mazej
19. Training in Radiochemistry and Radioactivity Measurements for Practitioners from
Countries Eligible under the JRC Enlargement & Integration Policy
Institute For Reference Materials And Measurements
Prof. Ljudmila Benedik
20. Training Fee for Ms Christiane Odumah Anderson, (Ghana), 1.10. - 24. 12. 2012, 8.9-
7.12.2013
Ictp - Centro Internazionale Di Fisica Teorica
Prof. Milena Horvat
21. SOP WHO - Standard Operating Procedure
World Health Organization
Prof. Milena Horvat
22. Determination of Ag in Chicken Paste and Ag Suspension by k0-INAA
Institute For Reference Materials And Measurements
Dr. Radojko Jačimović
23. Determination of Ag in Ag Suspension by k0-INAA
Institute For Reference Materials And Measurements
Dr. Radojko Jačimović
24. Techno-economic Evaluation of Options for Adapting Nuclear and Other Energy
Infrastructure to Long-term Climate Change and Extreme Weather
IAEA - International Atomic Energy Agency
Prof. Branko Kontić
25. Determination of Total Na and Cl in Ion Exchange Resins by K0-INAA
University Of Pavia (Iena)
Dr. Radojko Jačimović
26. Determination of Trace Elements in Lu Foil by k0-INAA and XRF
Institute For Reference Materials And Measurements
Dr. Radojko Jačimović
27. Stability Study of ERM-EC680k and ERM-EC681k
Institute For Reference Materials And Measurements
Dr. Radojko Jačimović
28. IAEA Fellowships for Mr Baktyiar Zholboldiev, Ms Asel Seitkazieva and Mr Asankul
Nurabaev, KIG/13006, KIG/13012, KIG/13013, 22.04.2013 - 21.06.2013
IAEA - International Atomic Energy Agency
Prof. Ljudmila Benedik
29. Training Fee for Ms Ilona Matveyeva, (Kazakhstan), 1.6.-29.8.2013
Ictp - Centro Internazionale Di Fisica Teorica
Prof. Milena Horvat
30. The Stability Study for Br in ERM-EC590 and ERM-EC591 by k0-INAA
Institute For Reference Materials And Measurements
Dr. Radojko Jačimović
31. Stability Study of ERM-CE278k by CVAAS, ICP-MS and k0-INAA
Institute For Reference Materials And Measurements
Dr. Radojko Jačimović
32. IAEA Fellowship for Mr Dejan Jani, MNE/12007, 2.9.-1.11.2013; Analysis and Speciation
of Trace Elements by ICP MS and Similar Techniques
IAEA - International Atomic Energy Agency
Prof. Milena Horvat
33. The Stability Study for Co, Sb, Se, V and Zn in Coal Materials; Stability Study of ERM-
EF411 by k0-INAA
Institute For Reference Materials And Measurements
Dr. Radojko Jačimović
34. The Use of Stable Isotopes and Elemental Composition for Determination of
Authenticity and Geographical Origin of Milk and Dairy Products; Accessible
Technologies for the Verification of Origin of Dairy Products as an Example Control
System...
IAEA - International Atomic Energy Agency
Prof. Nives Ogrinc

35. Stability Study of ERM-EC590 and ERM-EC591 by k0-INAA
Institute For Reference Materials And Measurements
Dr. Radojko Jačimović
36. Stability Monitoring of ERM-CE477; Measurements of Monobutyltin (MBT), Dibutyltin (DBT) and Tributyltin (TBT) in the Reference Material ERM-CE477
Institute For Reference Materials And Measurements
Dr. Tea Zuliani
37. IAEA Fellowship for Ms Snežana Andelić, MNE/12008, 11.11.-10.12.2013
IAEA - International Atomic Energy Agency
Prof. Milena Horvat
38. Determination of Au in Al-Au Alloy by INAA
Institute For Reference Materials And Measurements
Dr. Radojko Jačimović
39. Mercury Analysis and Speciation in the Oceans
Javna agencija za raziskovalno dejavnost RS
Prof. Milena Horvat
40. Fluid Dynamics and Carbon Cycling in Sedimentary Basins: Geochemical Characterization, Evaluation of Biogeochemical Processes and Modeling
Javna agencija za raziskovalno dejavnost RS
Dr. Tjaša Kanduč
41. Calibration of Palaeoenvironmental Records in (Sub)recent Laminated Tufa
Javna agencija za raziskovalno dejavnost RS
Prof. Sonja Lojen
42. Determination of Toxicity and Physico-chemical Properties of Pharmaceuticals
Javna agencija za raziskovalno dejavnost RS
Dr. Tina Kosjek
43. Tracing of Natural and Anthropogenic Impacts in Marine Ecosystem Along Istrian Adriatic Coast Using Mediterranean Mussel *M. Galloprovincialis*
Javna agencija za raziskovalno dejavnost RS
Dr. Tjaša Kanduč
44. Environmental Isotopes in Snow Hydrology
Javna agencija za raziskovalno dejavnost RS
Dr. Polona Vreča
45. Mercury Processes in Aquatic Systems; Mercury Methylation and Reduction in Natural Aquatic Environments: Laboratory Studies using High Specific Activity 197Hg Radiotracer
Javna agencija za raziskovalno dejavnost RS
Prof. Milena Horvat
46. Where Radon (Gaseous Soil Component) is coming from?
Javna agencija za raziskovalno dejavnost RS
Prof. Janja Vaupotič
47. Evaluating the Vulnerability of Groundwater Resources using Groundwater Tracers
Javna agencija za raziskovalno dejavnost RS
Prof. Nives Ogrinc
48. The Impact of Colloidal Particles on the Fate of Trace Elements in Environmental Compartments
Javna agencija za raziskovalno dejavnost RS
Prof. Radmila Milačič
- to support the development of cost-effective removal technologies
Prof. Milena Horvat
9. The effect of iodine and selenium on growth and quality of crops
Prof. Vekoslava Stibilj
10. Groundwater age determination in deep aquifers of Slovenia
Prof. Sonja Lojen
11. Sediments in aquatic environments: their geochemical and mineralogical characterization, remediation, and use as secondary raw materials
Prof. Radmila Milačič
12. Petrology of brown (low-rank) coals as mined and/or used in Slovenia, natural gasses in them, and their gas-sorption properties
Dr. Tjaša Kanduč
13. Carbon dynamics in forest soils and the rhizosphere
Prof. Nives Ogrinc
14. Optimization and validation of new indicator systems in complex environmental matrices
Prof. Milena Horvat
15. Evaluating geological sequestration of CO₂ in low rank coals; Velenje basin, Slovenia as a natural analogue
Dr. Tjaša Kanduč
16. Pharmaceutical and personal care product residues in the environment: Occurrence, sources, treatment and effects
Prof. Ester Heath
17. Farming Possibilities in Water Protection Areas
Prof. Sonja Lojen
18. Farming Possibilities in Water Protection Areas
Prof. Sonja Lojen
19. The use of specific methods for determination and prevention of adulteration of milk and dairy products
Prof. Nives Ogrinc
20. The use of specific methods for determination and prevention of adulteration of milk and dairy products
Prof. Nives Ogrinc
21. Quality of fish on Slovenian market and analysis of possibilities to adjust supply to demand with respect to secure nutritional safety and increase competitiveness of fisheries and aquaculture(Healthy fish - healthy as fish: competitive fisherman
Prof. Vekoslava Stibilj
22. Quality of fish on Slovenian market and analysis of possibilities to adjust supply to demand with respect to secure nutritional safety and increase competitiveness of fisheries and aquaculture(Healthy fish - healthy as fish: competitive fisherman
Prof. Vekoslava Stibilj
23. EMRP - PartEmission; Emerging Requirements for Measuring Pollutants from Automotive Exhaust Emissions
Prof. Milena Horvat
24. EMRP; Traceable Measurements for Monitoring Critical Pollutants under the European Water Framework Directive (WFD-2000/60/EC)
Prof. Radmila Milačič
25. Analyses of Carbon and Oxygen
Dr. Polona Vreča
26. Chinese-Norwegian-Slovenian Workshop: "Mercury, Environment, Health and Cultural Heritage", 15-21 June 2013, Ljubljana, Slovenia
Prof. Milena Horvat
27. Determination of Elements in Environmental Samples by Neutron-activation Method using TRIGA Mark II Reactor
Prof. Borut Smodiš

RESEARCH PROGRAMS

1. Modelling and environmental impact assessment of processes and energy technologies
Prof. Borut Smodiš
2. Cycling of substances in the environment, mass balances, modelling of environmental processes and risk assessment
Prof. Milena Horvat

R&D GRANTS AND CONTRACTS

1. Tartary buckwheat as a new source for functional foods
Prof. Vekoslava Stibilj
2. Synthesis, characterisation and use of novel ruthenium compounds in electrochemotherapy of tumors (basic research project)
Prof. Janez Ščančar
3. Sustainable land use in relation to soil and crop quality
Prof. Nives Ogrinc
4. Metagenomics for bioexploration and biomining of bacterial laccases for a sustainable environment
Prof. Ester Heath
5. Archaeologies of hunter-gatherers, farmers and metallurgists: Cultures, populations, palaeoeconomies and climate
Prof. Nives Ogrinc
6. Advanced water treatment with ultrasound and cavitation
Prof. Ester Heath
7. Toxic metals and organometallic compounds in the terrestrial environment
Prof. Radmila Milačič
8. Speciation and interactions of chemical contaminants at trace level in aqueous media

NEW CONTRACTS

1. Evaluating geological sequestration of CO₂ in low rank coals; Velenje basin, Slovenia as a natural analogue
Premogovnik Velenje, d. d.
Dr. Tjaša Kanduč
2. Sustainability appraisal of energy policy development in Slovenia by 2030 with the emphasis on nuclear option.
Gen Energija, d. o. o.
Prof. Branko Kantič
3. Human biomonitoring in Zasavje - chemical analyses
Ministrstvo za Zdravje Republike Slovenije
Prof. Milena Horvat
4. Co-financing of activities of holder of national standard in 2013 - amount of substance / soil
Ministrstvo za Gospodarski Razvoj in Tehnologijo
Dr. Polona Vreča
5. Consultancy on environmental impact evaluations related to planned NPP2 Krško
GEN energija, d.o.o.
Prof. Branko Kantič
6. Optimization and validation of new indicator systems in complex environmental matrices

Inštitut za mikrobiološke znanosti
Prof. Milena Horvat

7. Pharmaceutical and personal care product residues in the environment: Occurrence, sources, treatment and effects
Institut za ekološki inženiring d.o.o.
Prof. Ester Heath

8. Pharmaceutical and personal care product residues in the environment: Occurrence, sources, treatment and effects
JP CCN Domžale-Kamnik d.o.o.
Prof. Ester Heath

VISITORS FROM ABROAD

1. Dr. Bojan Hamer, Emina Durmišić, Ruđer Bošković Institute, Center for Marine Research, Zagreb, Croatia, 18.-19. 1. 2013
2. Adrian Vicent Claramunt, Leonardo da Vinci Fellowship, Valencia, Spain, 25. 1.-23. 5. 2013
3. Michal Buch, University of Wrocław, Wrocław, Poland, 20. 2. 2013
4. Dávid Horváth, Institute of Radiochemistry and Radioecology, University of Pannonia, Veszprem, Hungary, 1. 3.-31. 5. 2013
5. Baktyiar Zholboldiev, Asel Seitkazieva, Asankul Nurabaev, Ministry of Emergency Situation of the Kyrgyz Republic, Agency for Managing Tailing under the Ministry of Emergency Situations of the Kyrgyz Republic, The Kyrgyz Republic. Biology and Soil Institute of the National Academy of Science KR, Laboratory Biogeo, Bishkek, Kyrgyz, 21. 4.-30. 6. 2013
6. Dr. Maria Angela Menezes, CDTN/CNEN, Belo Horizonte, Brazil, 14.-26. 5. 2013
7. Dr. Jennifer C. McIntosh, University of Arizona, Tucson, USA, 16.-24. 5. 2013
8. Iлона Matveyeva, Al-Farabi Kazakh National University, Almaty, Kazakhstan, 1. 6.-29. 8. 2013
9. Mariam Todadze, Institute of Geophysics, Ivane Javakhsishvili Tbilisi State University, Tbilisi, Georgia, 10.-25. 6. 2013
10. Tang Dingding, Liu Ning, Xia Yingxian, Fang Li, Wu Jianmin, Wang Zuguang, Ministry of Environmental Protection, Beijing, China, 15.-21. 6. 2013
11. Prof. Duan Lei, School of Environment, Tsinghua University, Beijing, China, 15.-21. 6. 2013
12. Prof. Feng Xinbin, Prof. Qiu, Guang, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, China, 15.-21. 6. 2013
13. Dr. Thorjorn Larssen, Dr. Yan Lin, Norwegian Institute for Water Research, Oslo, Norway, 15.-21. 6. 2013
14. Volodymyr Vashchenko, Ministry of Ecology and Natural Resources of Ukraine, Kiev, Ukraine, 12. 8. 2013
15. Olena Vashchenko, National Pedagogical Dragomanov University, Kiev, Ukraine, 12. 8. 2013
16. Dr. Dejan Jančić, PI Center for Ecotoxicological Research of Montenegro, Podgorica, Montenegro, 1. 9.-1. 11. 2013
17. Dr. Vladimir P. Smolyar, Department of Theoretical and Experimental Nuclear Physics, Odessa National Polytechnic University, Odessa, Ukraine, 3. 9.-4. 10. 2013
18. Prof. Ryoko Fujiyoshi, Faculty of Engineering, Hokkaido University, Sapporo, Japan, 10.-20. 9. 2013
19. Dr. Oleksandr Lyashchuk, National Antarctic Scientific Centre, Kiev, 21. 9.-25. 10. 2013
20. Dr. Volodymyr Bakhmutov, Institute of Geophysics, National Academy of Sciences of Ukraine, Kiev, Ukraine, 21. 9.-25. 10. 2013
21. Dr. Sergio Ribeiro Guevara, Centro Atómico Bariloche, Comisión Nacional de Energía Atómica, Bariloche, Argentina, 15. 9.-13. 10. 2013
22. Dr. John Bennett, The Australian Nuclear Science and Technology Organisation (ANSTO), Lucas Heights NSW, Australia, 27.-30. 9. 2013
23. Christiana Odumah Anderson, Department of Physics, University of Cape Coast, Cape Coast, Ghana, 9. 10.-7. 12. 2013
24. Dr. Neven Cukrov, Ruđer Bošković Institute, Zagreb, Croatia, 23. 10. 2013
25. Nuša Cukrov, Ruđer Bošković Institute, Zagreb, Croatia 4.-30. 11. 2013
26. Dr. George Melikadze, Mariam Todadze, Institute of Geophysics, Ivane Javakhsishvili Tbilisi State University, Tbilisi, Georgia, 14.-28. 11. 2013
27. Nikolay Kiyashko, General and Inorganic Chemistry Department, Al-Farabi Kazakh National University, Almaty, Kazakhstan 4.-11. 12. 2013
28. Nino Kapanadze, Vladimir Chikviladze, Institute of Geophysics, Ivane Javakhsishvili Tbilisi State University, Tbilisi, Georgia, 8.-24. 12. 2013
29. Dr. Zora S. Žunić, Vinča Institute of Nuclear Sciences, Belgrade, Serbia, 15.-22. 12. 2013
30. Dr. Predrag Kolarž, Institut za fiziku, Belgrade, Serbia, 15.-22. 12. 2013
31. Elizaveta Mochalova, Geological Institute of the Russian Academy of Sciences, Moscow, Russia, 9.-19. 12. 2013
32. Konstantin Ossipov, Lomonosov Moscow State University, Moscow, Russia, 9.-19. 12. 2013
33. Dalė Baranauskienė, Vaida Bakšenskaitė, Lithuanian University of Health Sciences Neuroscience Institute, Kaunas, Lithuania, 9.-19. 12. 2013
34. Biljana Manevska, Department of reference laboratories Trace elements analysis laboratory, Institute of Public Health of R. Macedonia, Skopje, Macedonia, 9.-19. 12. 2013
35. Nataša Janev Holcer, Croatian National Institute of Public Health, Zagreb, Croatia, 9.-19. 12. 2013
36. Snežana Andelić, Center for Ecotoxicological Research of Montenegro, Podgorica, Montenegro, 11. 11.-10. 12. 2013
37. Dr. Giulio Cozzi, Fabio P. Polo, Ca' Foscari University, Venice, Italy, 20. 12. 2013
38. Prof. Gaetane Lespes, University of Pau, France, 23.-27. 12. 2013

STAFF

Researchers

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16. Prof. Janez Ščančar
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18. Prof. Janja Vaupotič
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20. Dr. Tea Zuliani
21. Dr. Dušan Žigon
22. **Postdoctoral associates**
22. Dr. Urška Dermol, left 01.04.13
23. Dr. Tjaša Kanduč
24. Dr. Davor Kontić
25. Dr. Darja Mazej
26. Dr. Ana Miklavčič Višnjevec
27. Dr. Marko Štok
28. Dr. Mitja Vahčić, left 01.03.13

Postgraduates

29. Ermira Begu, B. Sc.
30. Dr. Mateja Bezek, left 01.04.13
31. Dr. Arne Bratkič
32. Marko Černe, B. Sc., left 24.10.13
33. Marjeta Česen, B. Sc.
34. Dr. Marinka Gams Petrišič, left 01.07.13
35. Dr. Asta Gregorič, left 01.04.13
36. Ana Jerše, B. Sc.
37. Urška Kristan, B. Sc.
38. Anže Martinčič, B. Sc.
39. Petra Novak, B. Sc.
40. Breda Novotnik, B. Sc.
41. Dr. Tina Oblak, left 01.04.13
42. Majda Pavlin, B. Sc.
43. Kelly Peeters, B. Sc.
44. Petra Planinšek, B. Sc.
45. Janja Snoj Tratnik, B. Sc.
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47. Janja Vidmar, B. Sc.
48. Saša Zavavlav, B. Sc., left 01.04.13
49. **Technical officer**
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51. Damjana Nikovski, B. Sc.
52. Silva Perko, B. Sc.
53. Janja Smrke
54. Barbara Svetek, B. Sc.
55. Zdenka Trkov, B. Sc.
56. Stojan Žigon

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Miha Avberšek, Bojana Žegura, Metka Filipič, Nataša Uranjek Ževart, Ester Heath, "Determination of estrogenic potential in waste water without sample extraction", *J. hazard. mater.*, vol. 260, pp. 527-533, 2013.
2. Martine Bellanger *et al.* (33 authors), "Economic benefits of methylmercury exposure control in Europe: Monetary value of neurotoxicity prevention", *Environmental health*, no. 3, vol. 12, 20 pp., 2013.
3. Ljudmila Benedik, "An overview of results obtained in intercomparison exercises for determination of actinides", In: Proceedings of the 6th International Conference on Radionuclide Metrology - Low Level Radioactivity Measurement Techniques, 17-21 September 2013, Jeju Island, Korea, *Appl. Radiat. Isot.*, vol. 81, pp. 10-13, 2013.
4. Mateja Bezek, Asta Gregorič, Janja Vaupotič, "Radon decay products and 10-1100 nm aerosol particles in Postojna Cave", *Nat. hazards earth syst. sci.*, vol. 13, no. 3, pp. 823-831, 2013.
5. Tanja Blagus, Boštjan Markelc, Maja Čemažar, Tina Kosjek, Véronique Préat, Damijan Miklavčič, Gregor Serša, "In vivo real time monitoring system of electroporation mediated control of transdermal and topical drug delivery", *J. control. release*, vol. 172, iss. 3, pp. 862-871, Dec. 2013.
6. Arne Bratkič, Nives Ogrinc, Jože Kotnik, Jadran Faganeli, Dušan Žagar, Shinichiro Yano, Akihide Tada, Milena Horvat, "Mercury speciation driven by seasonal changes in a contaminated estuarine environment", In: International Workshop on Mercury in contaminated sites: characterization, impacts and remediation, 10-14 October, 2010, Piran, Slovenia, *Environ. Res.*, vol. 125, pp. 171-178, 2013.
7. Mihael Budja, Nives Ogrinc, Andreja Žibrat Gašparič, Doris Potočnik, Dušan Žigon, Dimitrij Mlekuž, "Transition to farming - transition to milk culture: a case study from Mala Triglavca, Slovenia", *Doc. Praehistor.*, 40, pp. 97-117, 2013.
8. Manuel Carmona, Willias Llanos, Pablo Leon Higuera, David Kocman, "Mercury emissions in equilibrium: a novel approach for the quantification of mercury emissions from contaminated soils", *Analytical methods*, vol. 5, issue 11, pp. 2793-2801, 2013.
9. M. Cinta Osácar, Concha Arenas, Marta Vázquez-Urbez, Carlos Sancho, Luis Auqué, Gonzalo Pardo, Sonja Lojen, Neven Cukrov, "Seasonal and decadal stable isotope evolution recorded by recent tufa deposited on artificial substrates in the Monasterio de Piedra Natural Park", *Geogaceta*, vol. 54, pp. 135-138, 2013.
10. Neven Cukrov, V. Cuculić, Delko Barišić, Sonja Lojen, L. Mikelić, V. Oreščanin, Neda Vdović, Ž. Fiket, Branko Čermelj, Marina Mlakar, "Elemental and isotopic records in recent fluvio-lacustrine sediments in karstic river Krka, Croatia", *J. geochem. explor.*, vol. 134, pp. 51-60, 2013.
11. Damjana Cvelbar, Vanja Žist, Katja Kobal, Dušan Žigon, Marija Žakelj-Mavrič, "Steroid toxicity and detoxification in fungi", In: Special issue of the 16th International Workshop on Molecular Biology of Carboxyl Metabolism, July 10-14, 2012, Plön, Germany, *Chem.-Biol. Interact.*, vol. 202, no. 1/3, pp. 243-258, 2013.
12. L. Deroma, Maria Parpinel, Veronika Tognin, L. Channoufi, Janja Snoj Tratnik, Milena Horvat, Francesca Valent, Fabio Barbone, "Neuropsychological assessment at school-age and prenatal low-level exposure to mercury through fish consumption in an Italian birth cohort living near a contaminated site", *Int. j. hyg. environ. health*, vol. 216, issue 4, pp. 486-493, 2013.
13. Ryoko Fujiyoshi, Masanori Okabayashi, Yosuke Sakuta, Kazumasa Okamoto, Takashi Sumiyoshi, Ivan Kobal, Janja Vaupotič, "Soil radon in winter months under snowpack in Hokkaido, Japan", *Environmental earth sciences*, vol. 70, issue 3, pp. 1159-1167, 2013.
14. Marinka Gams Petrišič, Gregor Muri, Nives Ogrinc, "Source identification of polycyclic aromatic hydrocarbons in Lake Bled (NW Slovenia) sediments using stable carbon isotopes", *Environ. sci. technol.*, vol. 47, issue 3, pp. 1280-1286, 2013.
15. Marinka Gams Petrišič, Nives Ogrinc, "Lipid biomarkers of suspended particulate organic matter in Lake Bled (NW Slovenia)", *Geomicrobiol. j.*, vol. 30, issue 4, pp. 291-301, 2013.
16. Mateja Germ, Paula Pongrac, Marjana Regvar, Katarina Vogel-Mikuš, Vekoslava Stibilj, Radojko Jačimović, Ivan Krefc, "Impact of double Zn and Se biofortification of wheat plants on the element concentrations in the grain", *Plant, soil and environment*, vol. 59, no. 7, pp. 316-321, 2013.
17. Denis Glavič-Cindro, Ljudmila Benedik, Jasmina Kožar Logar, Branko Vodenik, Benjamin Zorko, "Detection of Fukushima plume within regular Slovenian environmental radioactivity surveillance", In: Proceedings of the 6th International Conference on Radionuclide Metrology - Low Level Radioactivity Measurement Techniques, 17-21 September 2013, Jeju Island, Korea, *Appl. Radiat. Isot.*, vol. 81, pp. 374-378, 2013.
18. Asta Gregorič, Janja Vaupotič, Franci Gabrovšek, "Reasons for large fluctuation of radon and CO₂ levels in a dead-end passage of a karst cave (Postojna Cave, Slovenia)", *Nat. hazards earth syst. sci.*, vol. 13, no. 2, pp. 287-297, 2013.
19. Asta Gregorič, Janja Vaupotič, Kardos Richárd, Mária Horváth, Tibor Bujtor, Tibor Kovács, "Radon emanation of soils from different lithological units", *Carpathian journal of earth and environmental sciences*, vol. 8, no. 2, pp. 185-190, 2013.
20. Asta Gregorič, Janja Vaupotič, Stanka Šebela, "The role of cave ventilation in governing cave air temperature and radon levels (Postojna Cave, Slovenia)", *Int. j. climatol.*, 13 pp., 2013.
21. B.T. Guerra, Radojko Jačimović, Maria Angela Menezes, A.S. Leal, "Proposed design for the PGAA facility at the TRIGA IPR-R1 research reactor", *SpringerPlus*, vol. 2, 10 pp., 2013.
22. Jacks Gunnar, Zdenka Šlejkovec, Magnus Mörth, P. Bhattacharya, "Redox-cycling of arsenic along the water pathways in sulfidic metasediment areas in northern Sweden", *Appl. geochem.*, vol. 35, pp. 35-43, 2013.
23. D. Halder, S. Bhowmick, Asit K. Biswas, D. Chatterjee, Jerome O. Nriagu, R. B. Mazumder, Zdenka Šlejkovec, Gunnar Jacks, P. Bhattacharya, "Risk of arsenic exposure from drinking water and dietary components: Implications for risk management in rural Bengal", *Environ. sci. technol.*, vol. 47, issue 2, pp. 1120-1127, 2013.
24. Tjaša Kanduč, Martina Burnik Šturm, Jennifer McIntosh, "Chemical dynamics and evaluation of biogeochemical processes in alpine river Kamniška Bistrica, North Slovenia", *Aquat. geochem.*, vol. 19, issue 4, pp. 323-346, 2013.
25. Ajda Koceli, Tjaša Kanduč, Timotej Verbovšek, "Anorganski ogljikov cikel v sistemu tla-kamnina-podzemna voda v kraško-razpoklinskih vodonosnikih", *Geologija*, 56, no. 2, pp. 219-228, 2013.
26. David Kocman, Scott Brooks, Carrie Miller, Xiangping Yin, "Evaluation of centrifugal ultrafilters for size fractionation of total mercury and methylmercury in freshwaters", *Environmental chemistry*, vol. 10, issue 4, pp. 323-332, 2013.
27. David Kocman, Milena Horvat, Nicola Pirrone, Sergio Cinnirella, "Contribution of contaminated sites to the global mercury budget", In: International Workshop on Mercury in contaminated sites: characterization, impacts and remediation, 10-14 October, 2010, Piran, Slovenia, *Environ. Res.*, vol. 125, pp. 160-170, 2013.
28. Neža Koron, Jadran Faganeli, Ingrid Falnoga, Darja Mazej, Katja Klun, Nives Kovač, "Association of macroaggregates and metals in coastal waters", *Mar. Chem.*, vol. 157, pp. 185-193, 2013.
29. Mojca Korošec, Terezija Golob, Jasna Bertonec, Vekoslava Stibilj, Barbara Koroušič-Seljak, "The Slovenian food composition database", In: Food composition and sustainable diets, 9th International Food Data Conference, September 14-17, 2011, Norwich, United Kingdom, *Food Chem.*, vol. 140, no. 3, pp. 495-499, 2013.
30. Barbara Koroušič-Seljak, Vekoslava Stibilj, Larisa Pograjc, Nataša Fidler Mis, Evgen Benedik, "Food composition databases for effective quality nutritional care", In: Food composition and sustainable diets, 9th International Food Data Conference, September 14-17, 2011, Norwich, United Kingdom, *Food Chem.*, vol. 140, no. 3, pp. 495-499, 2013.
31. Tina Kosjek, Tanja Dolinšek, Darja Gramec, Ester Heath, Primož Strojnar, Gregor Serša, Maja Čemažar, "Determination of vinblastine in tumor tissue with liquid chromatography high resolution mass spectrometry", *Talanta (Oxford)*, vol. 116, pp. 887-893, 2013.
32. Tina Kosjek, Silva Perko, Dušan Žigon, Ester Heath, "Fluorouracil in the environment: analysis, occurrence, degradation and transformation", *J. chromatogr. A*, vol. 1290, pp. 62-72, 2013.
33. Tibor Kovács, Gábor Szeiler, Ferenc Fábíáni, Kardos Richárd, Asta Gregorič, Janja Vaupotič, "Systematic survey of natural radioactivity of soil in Slovenia", *J. environ. radioact.*, no. 122, pp. 70-78, 2013.
34. Nives Kovač, Neli Glavaš, Matej Dolenc, Nastja Rogan Šmuc, Zdenka Šlejkovec, "Chemical composition of natural sea salt from the Sečovlje salina (Gulf of Trieste, northern Adriatic)", *Acta chim. slov.*, vol. 60, no. 3, pp. 706-714, 2013.

35. Krzysztof Kozak, Jadwiga Mazur, Janja Vaupotič, Dominik Grządziel, Ivan Kopal, Khaled M. H. Omran, "The potential health hazard due to elevated radioactivity in old uranium mines in Dolina Białego, Tatra Mountains, Poland", *Isot. environ. health stud.*, vol. 49, issue 2, pp. 274-282, 2013.
36. Ivan Kreft, Špela Mechora, Mateja Germ, Vekoslava Stibilj, "Impact of selenium on mitochondrial activity in young Tartary buckwheat plants", *Plant physiol. biochem. (Paris)*, vol. 63, pp. 196-199, 2013.
37. Urška Kristan, Maria Arribére, Vekoslava Stibilj, "Selenium species and their distribution in freshwater fish from Argentina", *Biol. trace elem. res.*, vol. 151, issue 2, pp. 240-246, 2013.
38. Anže Martinčič, Maja Čemažar, Gregor Serša, Viljem Kovač, Radmila Milačič, Janez Ščančar, "A novel method for speciation of Pt in human serum incubated with cisplatin, oxaliplatin and carboplatin by conjoint liquid chromatography on monolithic disks with UV and ICP-MS detection", *Talanta (Oxford)*, vol. 116, pp.141-148, 2013.
39. Špela Mechora, Vekoslava Stibilj, Mateja Germ, "The uptake and distribution of selenium in three aquatic plants grown in Se(IV) solution", *Aquat. toxicol.*, vol. 128/129, pp. 53-59, 2013.
40. Ana Miklavčič, Anica Casetta, Janja Snoj Tratnik, Darja Mazej, Mladen Krsnik, Marika Mariuz, Katia Sofianou, Zdravko Špirić, Fabio Barbone, Milena Horvat, "Mercury, arsenic and selenium exposure levels in relation to fish consumption in the Mediterranean area", *Environ. Res.*, vol. 120, pp. 7-17, 2013.
41. Ana Miklavčič, Darja Mazej, Radojko Jačimovič, Tatjana Dizdarevič, Milena Horvat, "Mercury in food items from the Idrija Mercury Mine area", In: International Workshop on Mercury in contaminated sites: characterization, impacts and remediation, 10-14 October, 2010, Piran, Slovenia, *Environ. Res.*, vol. 125, pp. 61-68, 2013.
42. Ana Mladenovič, Željko Pogačnik, Radmila Milačič, Ana Petkovšek, Franka Cepak, "Dredged mud from the Port of Koper - civil engineering applications", *Mater. tehnol.*, vol. 47, no. 3, pp. 353-356, maj-jun. 2013.
43. Dimitrij Mlekuž, Nives Ogrinc, Milena Horvat, Andreja Žibrat Gašparič, Marinka Gams Petrišič, Mihael Budja, "Pots and food: uses of pottery from Resnikov prekop", *Doc. Praehistor.*, 40, pp. 131-146, 2013.
44. Gregor Muri, Branko Čermelj, Radojko Jačimovič, Dragomir Skaberne, Andrej Šmuc, Martina Burnik Šturm, Janja Turšič, Polona Vreča, "Consequences of anthropogenic activity for two remote alpine lakes in NW Slovenia as tracked by sediment geochemistry", *J. paleolimnol.*, vol. 50, no. 4, pp. 457-470, 2013.
45. Breda Novotnik, Tea Zuliani, Janez Ščančar, Radmila Milačič, "Chromate in food samples: an artefact of wrongly applied analytical methodology?", *J. anal. at. spectrom.*, vol. 28, no. 4, pp. 558-566, 2013.
46. Andrej Osterc, Vekoslava Stibilj, "¹²⁹I levels in soils from Ukraine and Slovenia in the last decade", *Int. j. environ. anal. chem.*, vol. 93, issue 5, pp. 553-564, 2013.
47. Natalia Pawlas *et al.* (29 authors), "Cadmium, mercury and lead in the blood of urban women in Croatia, the Czech Republic, Poland, Slovakia, Slovenia, Sweden, China, Ecuador and Morocco", *Int. J. Occup. Med. Environ. Health*, vol. 26, no. 1, pp. 58-72, 2013.
48. Martin Petkovšek, Mojca Zupanc, Matevž Dular, Tina Kosjek, Ester Heath, Boris Kompore, Brane Širok, "Rotation generator of hydrodynamic cavitation for water treatment", *Sep. purif. technol.*, vol. 118, pp. 415-423, Oct. 2013.
49. Branko Petrinc, Marko Štrok, Zdenko Franič, Borut Smodiš, Dijana Pavičič Hamer, "Radionuclides in the adriatic sea and related dose-rate assessment for marine biota", *Radiat. prot. dosim.*, vol. 154, no. 3, str. 320-330, 2013.
50. Petra Planinšek, Ljudmila Benedik, Borut Smodiš, "Comparison of various dissolution techniques for determination of Po-210 in biological samples", In: Proceedings of the 6th International Conference on Radionuclide Metrology - Low Level Radioactivity Measurement Techniques, 17-21 September 2013, Jeju Island, Korea, *Appl. Radiat. Isot.*, vol. 81, pp. 53-56, 2013.
51. P. P. Povinec, Z. Ženišová, A. Šivo, Nives Ogrinc, M. Richtáriková, R. Breier, "Radiocarbon and stable isotopes as groundwater tracers in the Danube river basin of SW Slovakia", In: Proceedings of the 21st International Radiocarbon Conference, 9-13 July 2012, Paris, France, *Radiocarbon*, vol. 55, no. 2/3, pp. 1017-1028, 2013.
52. Katja Rade, Anže Martinčič, Saša Novak, Spomenka Kobe, "Feasibility study of SiC-ceramics as a potential material for bone implants", *J. Mater. Sci.*, vol. 48, issue 15, pp. 5295-5301, 2013.
53. Vladimir Radulović, Andrej Trkov, Radojko Jačimovič, Robert Jeraj, "Measurement of the neutron activation constants Q_0 and k_0 for the $^{27}\text{Al}(n, \gamma)^{28}\text{Al}$ reaction at the JSI TRIGA Mark II reactor", *J. radioanal. nucl. chem.*, no. 3, vol. 298, pp. 1791-1800, 2013.
54. Vanja Ramšak, Vlado Malačič, Matjaž Ličer, Jože Kotnik, Milena Horvat, Dušan Žagar, "High-resolution pollutant dispersion modelling in contaminated coastal sites", *Environ. res. (N.Y.)*, no. 125, pp. 103-112, avg. 2013.
55. Sergio Ribeiro Guevara, Milena Horvat, "Stability and behaviour of low level spiked inorganic mercury in natural water samples", *Analytical methods*, vol. 5, issue 8, pp. 1996-2006, 2013.
56. Martina Rožmarič, Matea Rogić, Ljudmila Benedik, Marko Štrok, Delko Barišič, "Seasonal and spatial variations of ^{210}Po and ^{210}Pb activity concentrations in *Mytilus galloprovincialis* from Croatian coast of the Adriatic Sea", *Chemosphere (Oxford)*, vol. 93, issue 9, pp. 2063-2068, 2013.
57. Borut Smodiš, Marko Štrok, "Partitioning of natural radionuclides in sediments around a former uranium mine and mill", In: Conference proceedings, 10th International Conference on Nuclear Analytical Methods in the Life Sciences (NAMLS-10), January 15-29, 2012, *J. Radioanal. Nucl. Chem.*, vol. 297, iss. 2, pp. 201-207, 2013.
58. Borut Smodiš, Marko Štrok, Marko Černe, Petra Planinšek, Ljudmila Benedik, "Radioanalytical techniques for the determination of ^{238}U , ^{226}Ra and ^{210}Pb in the environment", In: Proceedings of the 8th International Conference on Nuclear and Radiochemistry, 16-21 September 2012, Como, Italy, *Radiochim. Acta*, vol. 101, no. 8, pp. 519-524, 2013.
59. Andrej Stergaršek, Milena Horvat, Peter Frkal, Sergio Ribeiro Guevara, Robert Kocjančič, "Removal of Hg^0 in wet FGD by catalytic oxidation with air - A contribution to the development of a process chemical model", *Fuel (Guildf.)*, vol. 107, pp. 183-191, 2013.
60. Janez Ščančar, Tea Zuliani, Radmila Milačič, "Study of nickel content in Ni-rich food products in Slovenia", *J. food compos. anal.*, vol. 32, no. 1, pp. 83-89, 2013.
61. Janez Ščančar, Tea Zuliani, Dušan Žigon, Radmila Milačič, "Ni speciation in tea infusions by monolithic chromatography/ICP-MS and Q-TOF-MS", *Anal. bioanal. chem.*, vol. 405, no. 6, pp. 2041-2051, 2013.
62. Marko Štrok, Borut Smodiš, "Soil-to-plant transfer factors for natural radionuclides in grass in the vicinity of a former uranium mine", *Nucl. Eng. Des.*, vol. 261, pp. 279-284, 2013.
63. Marko Štrok, Borut Smodiš, Branko Petrinc, Zdenko Franič, "Correcting for potential ^{222}Rn loss in ^{210}Pb dating of sediments from the South Adriatic Pit", *Quaternary geochronology*, vol. 18, pp. 93-98, 2013.
64. Francesca Valent *et al.* (11 authors), "Neurodevelopmental effects of low-level prenatal mercury exposure from maternal fish consumption in a Mediterranean cohort: study rationale and design", *J. epidemiol.*, vol. 23, no. 2, pp. 146-152, 2013.
65. L. Valiente *et al.* (25 authors), "Final report on APMP-QM-S5: Essential and toxic elements in seafood", *Metrologia*, technical Supplement 20, no. 1A, vol. 50, 47 pp., 2013.
66. L. Valiente *et al.* (45 authors), "Final report on CCQM-K89: Trace and essential elements in Herba Ecliptae", *Metrologia*, no. 1A, technical Supplement 20, vol. 50, 53 pp., 2013.
67. Janja Vaupotič, Thomas Streil, Shinji Tokonami, Zora S. Žunič, "Diurnal variations of radon and thoron activity concentrations and effective doses in dwellings in Niška Banja, Serbia", *Radiat. prot. dosim.*, vol. 157, issue 3, pp. 375-382, 2013.
68. A. Vidic, Zorana Ilić, Ljudmila Benedik, "Recent measurements of $^{234}\text{U}/^{238}\text{U}$ isotope ratio in spring waters from the Hadzici area", *J. environ. radioact.*, vol. 120, pp. 6-13, 2013.
69. D. Vromman, Stanley Lutts, I. Lefevre, L. Somer, O. De Vreese, Zdenka Šlejkovec, Murielle Quinet, "Effects of simultaneous arsenic and iron toxicities on rice (*Oryza sativa* L.) development, yield-related parameters and As and Fe accumulation in relation to As speciation in the grains", *Plant soil*, vol. 371, issue 1-2, pp. 199-217, 2013.
70. Saša Zavadlav, Tjaša Kanduč, Jennifer McIntosh, Sonja Lojen, "Isotopic and chemical constraints on the biogeochemistry of dissolved inorganic carbon and chemical weathering in the karst watershed of Krka river (Slovenia)", *Aquat. geochem.*, vol. 19, issue 3, pp. 209-230, 2013.
71. Tea Zuliani, Janez Ščančar, Radmila Milačič, "The use of stable isotopes for Cr(VI) determination in silty-clay soil solution", *Anal. bioanal. chem.*, vol. 405, no. 23, pp. 7231-7240, 2013.
72. Mojca Zupanc, Tina Kosjek, Martin Petkovšek, Matevž Dular, Boris Kompore, Brane Širok, Željko Blažeka, Ester Heath, "Removal of pharmaceuticals from wastewater by biological processes, hydrodynamic cavitation and UV treatment", *Ultrason. sonochem.*, vol. 20, no. 4, pp. 1104-1112, 2013.

SHORT ARTICLE

1. Krisztina Kármán, József Deák, István Fórizs, Juraj Michalko, Radovan Černak, Nives Ogrinc, Nada Horvatinčič, Nada R. Miljević, Marin Ivanov,

"Examining riparian drinking water resources in the Danube basin", *Water & environment news*, no. 32, pp. 9-10, sep. 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

1. Janja Vaupotič, Asta Gregorič, Miha Leban, Mateja Bezek, Petra Žvab Rožič, Boris Zmazek, Ivan Kobal, "Radon survey within a regular grid in homes in Slovenia", In: *VII. Hungarian Radon Forum and Radon and Environment Satellite Workshop: Veszprém, 2013*, Veszprém, Pannonian University Press, 2013, pp. 195-200.

PUBLISHED CONFERENCE CONTRIBUTION

1. Ermira Begu, Vesna Fajon, Milena Horvat, "Testing of bottles for storage of precipitation samples for Hg measurements", In: *[Program and abstract book], 7th Young Researchers' Day, 19 February, 2013*, Ljubljana, Slovenia, Darja Lisjak, ed., Peter Dušak, ed., Slavko Kralj, ed., Ljubljana, Institut Jožef Stefan, 2013, pp. 47.
2. Mihael Brenčič, Hermina Ivanuša-Šket, Anja Torkar, Polona Vreča, "Influences of sanitary landfill on groundwater under the complex hydrogeological conditions", In: *SARDINIA 2013: executive summaries: 14th International waste management and landfill symposium, 30 September - 4 October 2013, Forte Village, S. Margherita di Pula, Cagliari, Sardinia, Italy, (Sardinia... (Padova))*, Raffaello Cossu, ed., Cagliari, CISA, cop. 2013, 10 pp.
3. Mihael Brenčič, Hermina Ivanuša-Šket, Anja Torkar, Polona Vreča, "Vpliv odlagališča odpadkov na podzemno vodo v kompleksnih hidrogeoloških pogojih", In: *Razprave, poročila*, (Geološki zbornik, 22), 21. posvetovanje slovenskih geologov, Ljubljana, 2013 = 21st Meeting of Slovenian Geologists, Ljubljana, 2013, Boštjan Rožič, ed., Ljubljana, Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za geologijo, 2013, pp. 20-21.
4. Sergio Cinnirella, Nicola Pirrone, Milena Horvat, David Kocman, "Daysimetric mapping of mercury emissions from contaminated sites", In: *Proceedings of the 16th International Conference on Heavy Metals in the Environment, September 23-27, 2012, Rome, Italy*, (E3S web of conferences, vol. 1), Nicola Pirrone, ed., 4 pp.
5. Sergio Cinnirella, Nicola Pirrone, Milena Horvat, David Kocman, Jože Kotnik, "Mercury bioaccumulation in the Mediterranean", In: *Proceedings of the 16th International Conference on Heavy Metals in the Environment, September 23-27, 2012, Rome, Italy*, (E3S web of conferences, vol. 1), Nicola Pirrone, ed., 4 pp.
6. Marjeta Česen, Tina Kosjek, Ester Heath, "Degradation of cytostatics cyclophosphamide, ifosfamide and their human metabolites by UV irradiation", In: *Slovenski kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, 10 pp.
7. Marjeta Česen, Tina Kosjek, Ester Heath, "Optimization of derivatization process for human metabolites of common cytostatics cyclophosphamide and ifosfamide", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013*, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 4-14.
8. Tamara Ferjan Stanič, Mihael Brenčič, Polona Vreča, "Določanje izvora embaliranih vod", In: *Razprave, poročila*, (Geološki zbornik, 22), 21. posvetovanje slovenskih geologov, Ljubljana, 2013 = 21st Meeting of Slovenian Geologists, Ljubljana, 2013, Boštjan Rožič, ed., Ljubljana, Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za geologijo, 2013, pp. 35-37.
9. Marinka Gams Petrišič, Nives Ogrinc, "Determination of the isotopic composition of polycyclic aromatic hydrocarbons in environmental samples", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013*, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 15-20.
10. Marko Gerbec, Branko Kontič, "Key performance indicators and bayesian belief network based risk model as a management tool-results from the case study", In: *Safety, reliability and risk analysis: beyond the horizon*, European Safety and Reliability Conference, ESREL 2013, Amsterdam, The Netherlands, 29 September - 2 October 2013, R. D. J. M. Steenbergen, ed., Boca Raton [etc.], CRC Press, 2013, pp. 1859-1865.
11. Aleksandra Golob, Judita Turk, Katja Klančnik, Igor Zelnik, Alenka Gaberščik, Ivan Kreft, Vekoslava Stibilj, Mateja Germ, "The effect of Se on Tartary and hybrid buckwheats under solar and reduced UV radiation treatments", In: *The proceedings of papers*, Mateja Germ, ed., et al, Pernica, Fagopyrum - slovensko društvo za promocijo ajde, 2013, pp. 74-76.
12. Anže Jazbec, Luka Snoj, Borut Smodiš, Andrej Lešnjak, "Periodic safety review of JSI TRIGA Mark II and inspection of the reactor", In: *Proceedings, Joint IGORR 2013 & IAEA technical meeting, October 13-18, 2013*, Daejeon, Daejeon, 2013, 6 pp.
13. Tjaša Kanduč, Zdenka Šlejkovec, Andrej Osterc, Urška Kristan, Vekoslava Stibilj, Andreja Ramšak, "Study on the behaviour of the biomarkers, stable isotopes and heavy metals using *Mytilus galloprovincialis* as a bioindicator species: the case of North Eastern Adriatic", In: *Razprave, poročila*, (Geološki zbornik, 22), 21. posvetovanje slovenskih geologov, Ljubljana, 2013 = 21st Meeting of Slovenian Geologists, Ljubljana, 2013, Boštjan Rožič, ed., Ljubljana, Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za geologijo, 2013, vol. 22, pp. 54-57, 2013.
14. Branko Kontič, "Strategic environmental consideration of nuclear power through comparative evaluation of energy options", In: *Proceedings of the 7th Conference on Sustainable Development of Energy, Water and Environmental Systems, July 1-7, 2012, Ohrid, Macedonia*, (Chemical engineering transactions, vol. 34, 2013), Milano, AIDIC, 2013, vol. 34, pp. 13-18, 2013.
15. Kristina Kotnik, Tina Kosjek, Uroš Krajnc, Ester Heath, "Behaviour of benzophenones under the influence of natural sunlight", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013*, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 50-59.
16. Urška Kristan, Vekoslava Stibilj, "Determination of selenium species and some other elements in wild and fish farm trout (*Onchorynchus mykiss*) and seabass (*Dicentrarchus labrax*)", In: *Proceedings, 23rd Annual Meeting of the Society of Environmental Toxicology and Chemistry (SETAC Europe)*, Glasgow, 12-16 May 2013, Glasgow, SETAC Europe, 2013.
17. Jerneja Lazar, Tjaša Kanduč, Sergej Jamnikar, Simon Zavšek, "Monitoring of coal gas composition distribution and gas origin at mining sites Pesje and Preloge in Velenje coal mine", In: *Razprave, poročila*, (Geološki zbornik, 22), 21. posvetovanje slovenskih geologov, Ljubljana, 2013 = 21st Meeting of Slovenian Geologists, Ljubljana, 2013, Boštjan Rožič, ed., Ljubljana, Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za geologijo, 2013, vol. 22, pp. 87-89, 2013.
18. Anže Martinčič, Radmila Milačič, Maja Čemažar, Gregor Serša, Janez Ščančar, "A novel method for speciation of Pt in human serum incubated with cisplatin, oxaliplatin and carboplatin by conjoint liquid chromatography on monolithic disks with UV and ICP-MS detection", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013*, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 33-39.
19. Petra Novak, Tea Zuliani, Janez Ščančar, Radmila Milačič, "Določanje polibromiranih difenil etrov v okoljskih vzorcih rečnih in morskih vod", In: *Slovenski kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, 7 pp.
20. Breda Novotnik, Tea Zuliani, Janez Ščančar, Radmila Milačič, "Chromate cannot exist in food samples", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013*, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 40-48.
21. Breda Novotnik, Tea Zuliani, Janez Ščančar, Radmila Milačič, "Vpliv tri in šestvalentnega kroma na proces nitrifikacije in porazdelitev šestvalentnega kroma v aktivnem blatu", In: *Slovenski kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, 6 pp.
22. Kristina Obu, Milena Horvat, "Določanje metil- in etil- živega srebra pod vplivom Hg(II) med procesom derivatizacije v vodnih vzorcih: napake in rešitve", In: *Slovenski kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, 4 pp.

23. Nives Ogrinc, Janez Ščančar, "Suspended particulate matter and water quality of the Sava river basin", In: *Proceedings of the 1st International Conference on the Status and Future of the World's Large Rivers, 11.-14. April 2011, Vienna, Austria*, (River system, Vol. 20, no. 3/4, 2013), Helmut Habersack, ed., Bernard Schober, ed., Desmond Eric Walling, ed., Stuttgart, Schweizerbart, 2013, vol. 20, no. 3/4, pp. 197-211, 2013.
24. Kelly Peeters, Tea Zuliani, Janez Ščančar, Radmila Milačič, "Transformation of organotin compounds in landfill leachate investigated by isotopically enriched tin species", In: *Slovenski kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, 6 pp.
25. Matea Rogić, M. Rožmarič Mačefat, Delko Barišič, Ljudmila Benedik, Petra Planinšek, "Koncentracije aktivnosti ^{210}Po i ^{210}Pb u dagnjama (Mytilus galloprovincialis) te procjena ukupne godišnje efektivne doze za priobalno stanovništvo Republike Hrvatske", In: *Zbornik radova 9. simpozija Hrvatskog društva za zaštitu od zračenja: HDZZ - CRPA: Zagreb 2013*, Željka Knežević, ed., Marija Majer, ed., Ines Krajcar Bronić, ed., Zagreb, Hrvatsko društvo za zaštitu od zračenja, 2013, pp. 229-234.
26. M. Rožmarič Mačefat, Matea Rogić, Delko Barišič, Ljudmila Benedik, Marko Štrok, "Sustavno praćenje radioaktivnosti priobalnih voda Jadrana korištenjem dagnji (Mytilus Galloprovincialis) kao bioindikatora", In: *Zbornik radova 9. simpozija Hrvatskog društva za zaštitu od zračenja: HDZZ - CRPA: Zagreb 2013*, Željka Knežević, ed., Marija Majer, ed., Ines Krajcar Bronić, ed., Zagreb, Hrvatsko društvo za zaštitu od zračenja, 2013, 361-366.
27. Matej Sedlar, Majda Pavlin, Sani Bašič, Milena Horvat, "Stability of mercury compounds at high temperatures: s", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 60-69.*
28. Matej Sedlar, Majda Pavlin, Robert Kocjančič, Sani Bašič, Milena Horvat, "Development of the method for temperature fractionation of mercury in solid samples", In: *6th International Conference on Clean Coal Technologies, CCT2013, 12-16 May 2013, Thessaloniki, Greece, London, IEA Clean Coal Centre, 2013, 13 pp.*
29. Mojca Simčič, Vekoslava Stibilj, Drago Kompan, Marko Čepon, Silvester Žgur, "The effect of production system on fatty acid composition in beef meat of Cika young bulls", In: *Animal science days, (Agriculturae Conspectus Scientificus, vol. 78, Number 3), International Symposium Animal Science Days, Enrico Sturaro, ed., Zagreb, University of Zagreb, Faculty of Agriculture, 2013, pp. 281-284.*
30. Anja Torkar, Mihael Brenčič, Polona Vreča, "Razdelitev hidrograma na primeru izvira reke Radovne", In: *Razprave, poročila, (Geološki zbornik, 22), 21. posvetovanje slovenskih geologov, Ljubljana, 2013 = 21st Meeting of Slovenian Geologists, Ljubljana, 2013, Boštjan Rožič, ed., Ljubljana, Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za geologijo, 2013, pp. 158-159.*
31. Urša Vežjak, Tjaša Kanduč, Nives Ogrinc, "Karakterizacija mleka in sira z uporabo stabilnih izotopov lahkih elementov (C, N in O) v Sloveniji", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 84-89.*
32. Adrian Vincent, Marinka Gams Petrišič, Marijan Nečemer, Nives Ogrinc, "Fatty acid composition as a tool for determination of geographical origin and authenticity of milk and dairy products", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 90-96.*
33. Polona Vreča, Mihael Brenčič, Iztok Sinjur, Gregor Vertačnik, Manca Volk Bahun, Jaka Ortar, Anja Torkar, Vekoslava Stibilj, Miha Pavšek, "Izotopska sestava padavin in snega na območju Julijskih Alp in Karavank", In: *Raziskave s področja geodezije in geofizike 2012: zbornik predavanj, 18. strokovno srečanje Slovenskega združenja za geodezijo in geofiziko, Ljubljana, 29. januar 2013, Miran Kuhar, ed., Ljubljana, Fakulteta za gradbeništvo in geodezijo, 2013, pp. 17-25.*
34. Polona Vreča, Mihael Brenčič, Anja Torkar, "Metodologija vzorčenja infiltracije tečnega snega", In: *Razprave, poročila, (Geološki zbornik, 22), 21. posvetovanje slovenskih geologov, Ljubljana, 2013 = 21st Meeting of Slovenian Geologists, Ljubljana, 2013, Boštjan Rožič, ed., Ljubljana, Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za geologijo, 2013, pp. 164-165.*
35. Janja Vrzel, Nives Ogrinc, "Uporaba izotopov pri raziskavah podzemnih vod", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 97-103.*
36. D. A. Vučić, D. Nikezić, Janja Vaupotič, Z. Stojanovska, D. Krstić, Zora S. Žunić, "Effective dose for real population exposed to indoor radon in dwellings of the former uranium mine area Kalna (Eastern Serbia)*", In: *Proceedings of the First East European Radon Symposium, September 2-5, 2012, Cluj-Napoca, Romania, (Romanian journal of physics, vol. 58, suppl., 2013), Constantin Cosma, ed., Dan Constantin Nită, ed., Alexandra Cuco. Dinu, ed., Bucure.ți, Editura Academiei Române, 2013, vol. 48, suppl., pp. S336-S347, 2013.*
37. Saša Zavadlav, Tjaša Kanduč, Sonja Lojen, "Carbonate weathering and biogeochemical carbon cycle in the Krka river watershed", In: *Razprave, poročila, (Geološki zbornik, 22), 21. posvetovanje slovenskih geologov, Ljubljana, 2013 = 21st Meeting of Slovenian Geologists, Ljubljana, 2013, Boštjan Rožič, ed., Ljubljana, Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za geologijo, 2013, vol. 22, pp. 178-181, 2013.*
38. Tea Zuliani, Milena Horvat, Polona Vreča, Radojko Jačimovič, Vesna Fajon, Andrej Osterc, Vekoslava Stibilj, "Kovine v sedimentu - medlaboratorijska primerjava PT-SED2", In: *Slovenski kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, 9 pp.
39. Tea Zuliani, Janez Ščančar, Radmila Milačič, "Ugotavljanje geografskega porekla olivnega olja na osnovi vsebnosti in izotopske sestave nekaterih elementov v sledovih", In: *Slovenski kemijski dnevi 2013, Maribor, 10.-12. september 2013*, Zdravko Kravanja, ed., Darinka Brodnjak-Vončina, ed., Miloš Bogataj, ed., Maribor, Fakulteta za kemijo in kemijsko tehnologijo, 2013, 9 pp.
40. Mojca Zupanc, Tina Kosjek, Martin Petkovšek, Matevž Dular, Boris Kompare, Brane Širok, Željko Blažeka, Ester Heath, "Removal of micropollutants by suspended biomass and biofilm processes and their improved removal by coupling biofilm process with alternative treatments", In: *Conference proceedings, 9th International Conference on Biofilm Reactors, May 28-31, 2013, Paris, France, [S. l.], IWA = International Water Association, 15 pp.*

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Sonja Lojen, David Kocman, Milena Horvat, "EGIDA methodology use case "Slovenia"", In: *Towards a sustainable geoss: [global earth observation system of systems], some results of the EGIDA project, (Environment and sustainability), Stefano Nativi, ed., Paolo Mazzetti, ed., Hans Peter Plag, ed., [S. l.], AiónEdizioni, 2013, pp. 91-103.*
2. Janez Ščančar, Radmila Milačič, "Aluminum speciation in human serum", In: *Encyclopedia of metalloproteins, Robert H. Kretsinger, ed., Vladimir N. Uversky, ed., Evgenii Anatol'evich Permiakov, ed., New York [etc.], Springer, cop. 2013, pp. 39-53.*

MENTORING

1. Mateja Bezek, *The role of nano aerosols in radon dosimetry*: doctoral dissertation, Ljubljana, 2013 (mentor Janja Vaupotič).
2. Arne Bratkič, *Biotransformation of mercury in the marine environment*: doctoral dissertation, Ljubljana, 2013 (mentor Milena Horvat; co-mentor Tamar Barkay).
3. Marinka Gams Petrišič, *Organic geochemistry of stratified eutrophic alpine lakes (Lake Bled)*: doctoral dissertation, Ljubljana, 2013 (mentor Nives Ogrinc).
4. Asta Gregorič, *Radon as a tool in geophysical research*: doctoral dissertation, Ljubljana, 2013 (mentor Janja Vaupotič).
5. Špela Mechora, *The impact of selenium on selected crops and aquatic plants*: doctoral dissertation, Ljubljana, 2013 (mentor Mateja Germ; co-mentor Vekoslava Stibilj).
6. Ana Miklavčič, *Mercury exposure assessment in the Slovenian population*: doctoral dissertation, Ljubljana, 2013 (mentor Milena Horvat).
7. Tina Oblak, *Environmental impacts of building materials containing by-products from steel industry*: doctoral dissertation, Ljubljana, 2013 (mentor Janez Ščančar; co-mentor Radmila Milačič).

8. Gregor Plestenjak, *Contribution of biogenic and geogenic CO₂ sources to soil CO₂ efflux on woody plant invaded calcareous pasture*: doctoral dissertation, Ljubljana, 2013 (mentor Dominik Vodnik; co-mentor Nives Ogrinc).
9. Saša Zavadlav, *CO₂ dynamics in a river system: mass balance, hydrological, geochemical and biochemical impacts*: doctoral dissertation, Ljubljana, 2013 (mentor Sonja Lojen).
10. Mojca Zupanc, *Removal of pharmaceutical residues from wastewater by biological and advanced oxidation processes*: doctoral dissertation, Ljubljana, 2013 (mentor Ester Heath; co-mentors Boris Kompare, Tina Kosjek).
11. Peter Frkal, *Removal of mercury from flue gas in wet desulphurization process*: master's thesis, Ljubljana, 2013 (mentor Marko Gerbec; co-mentor Milena Horvat).
12. Snežana Milošević, *Biomonitoring of air quality in Southern Serbia, Pčinja district*: master's thesis, Ljubljana, 2013 (mentor Zvonka Jeran; co-mentor Franc Batič).
13. Anja Stajniko, *Speciation of arsenic in tissue of selected cartilaginous fish from the Northern Adriatic*: master's thesis, Ljubljana, 2013 (mentor Damjana Drobne; co-mentor Zdenka Šlejkovec).
14. Sabina Žalig, *Influence of pharmaceuticals on the structure of bacterial community in pilot wastewater treatment plants*: master's thesis, Ljubljana, 2013 (mentor Ines Mandić-Mulec; co-mentor Ester Heath).

DEPARTMENT OF AUTOMATION, BIOCYBERNETICS AND ROBOTICS E-1

The research strategy within our department is unique, as it supports a variety of multi- and interdisciplinary research projects. Specifically, our research combines the fields of automatics, robotics (including intelligent control, humanoids, cognitive robotics, and robot vision), biocybernetics, kinesiology, ergonomics and environmental physiology. The common theme in all our research endeavours to date has been optimising “the behaviour of man and machine”, accounting for interactions with the environment. This past year we have added “human-robot partnership” as an additional goal of our research programme. By combining engineering sciences and life sciences, we have been able to make significant contributions to the development of: new methods for sensorimotor learning by imitation and coaching, a planetary habitat simulation facility, humanoid vision systems, manikins enabling the evaluation of protective garments for industry and recreation, kinematic models of the human body that serve as a basis for the design of anthropomorphic systems, and a medical treatment for frostbite.

The department maintains the Programme Group “Automatics, robotics and biocybernetics” in the field of Production Technology. The Programme group has three major overlapping research foci: automation and intelligent control (leader: doc. dr. Leon Žlajpah), humanoid and cognitive robotics (leader: dr. Aleš Ude), and biocybernetics: environmental physiology & ergonomics (leader: prof. dr. Igor B. Mekjavić). By maintaining a critical mass of researchers in all three areas within one Programme group, we have managed to foster exciting multidisciplinary projects.



Head:
Asst. Prof. Leon Žlajpah

During the past year, the main research topics in the department included humanoid robotics, the control of robot systems and learning strategies, studies of human physiology in extreme environments, an evaluation of protective equipment, the development of biomedical methods, and the automation of industrial manufacturing.

I. Automation and Intelligent Control

The research orientation within this group is primarily in the development of advanced control strategies for robot systems working in unstructured environments, bio-inspired control systems, cooperating robot systems, the control of multi-arm robots, and the automation of industrial processes.

Automation, robotics and factory information systems for manufacturing

In 2013 we implemented an automatic cell for a glassblowing operation and integrated it in regular production. The specific target environment is dedicated to the production of several hundred glass items; however, up to now it was predominantly manual. In addition, the technology of main manual operations execution was not formalized, but in a form of collective experience and skills of the human operators involved. We automated the key manual operation, which only a couple of skilled operators could perform satisfactorily.

Following the applied research and development activities, we implemented the automated solution, which has two aspects. The first part is a system for the construction of formal operation instructions based on the measurement and processing of skilled workers' actions. The second part is the automated cell that, based on the determined formal representations, carries out the glass item production operation. During work, the automated system adapts to parameter changes. It enables the inclusion of new glass objects.

Historical note: Since its inception the department has maintained an inter- and multidisciplinary research focus. The scientific inheritance of its founders includes pioneering research culminating in the first demonstration of how functional electrical stimulation can assist paraplegics to walk, and the development of the first industrial robots in our region. In addition to kinematics, the common denominator in the biomedical and robotic research is improving the quality of life.



Figure 1: System installation in a manufacturing cell and the training of operators

Advanced robot control

For tasks where more than one robot arm is cooperating the coordinated control becomes rather complex and the control algorithms are time demanding. Therefore, we propose to treat the two-arm or multi-arm robot systems as a single uniform system. This enables us a more efficient and simpler approach to develop control systems for cooperating robots. The advantages are especially noticeable when for the task execution the absolute position/

orientation of the robot end-effectors is not important but rather the relative position/orientation, or when the robot base is moving, e.g., mounted on a mobile platform. Our research focus was two-arm mechanisms. We have developed a method for the modelling of a combined robot mechanism, where the model of the complete system is generated by combining already known models of a particular robot mechanism. Additionally, we have included the task the robot has to perform as a part of the complete model of the robot systems. The task is represented as a virtual mechanism and the task execution is controlled by controlling the motion of this virtual mechanism. By

For the implementation of the applied R&D results, in 2013 we have received two awards:

- Golden award for innovation, Chamber of Commerce and Industry of Slovenia.
- Golden award for innovation, Zasavje Regional Chamber of Commerce and Industry.

treating the multi-arm robot system as a uniform system the self-motion, i.e., the redundancy, of the whole system can be exploited more easily, which is visible, especially when avoiding contacts with objects in the robot workspace.

Human in the loop

We developed methods to transfer human motor skills to the robots. These methods are based on including the human cognitive and sensorimotor capabilities into the robot control loop. By operating the robot, the human acquired the skill to perform tasks with the robot. The skill is then extracted/modelled using machine-learning tools and used for autonomous robot operation. The methods were validated on an industrial robot arm and a humanoid robot.

We utilized a special haptic interface to enclose the human tutor in the robot control loop. This interface provided the tutor with the feedback about the state of the humanoid robot upon which the human could react and move

We are using human cognitive and sensorimotor capabilities to teach the robot complex tasks that also require the variable compliance of the robot arm.

the robot body joints with the motion of their own body joints. The method for providing the feedback that we proposed is using information about the motion of the robot centre-of-mass and converts it into the forces that act on the human centre-of-mass. We used this method to teach the humanoid robot how to compliantly interact with the human partner.

Moreover, we developed a method for the multi-modal control and teaching of the robots. The robot motion was controlled by the tutor's arm motion measured by the motion capture system. Besides controlling and teaching the robot about the motion we also controlled and taught the robot how to modulate its stiffness by using electromyography (EMG). By allowing the robot arm to regulate its stiffness, we were able to teach the robot to perform dynamic tasks that involve interactions with an unstructured environment.

Whole-body Compliant Dynamical Contacts for Humanoid Robotics

We studied how humans utilize supportive hand contacts to counteract various postural perturbations. By emulating situations when the balance of an individual was challenged, we examined the functional role of supportive hand contact at different locations where the balance of an individual was perturbed by translational perturbations of the support surface. The effect of the handle position was significant for the perturbations in the posterior direction where the lowest maximum forces were recorded in the handle located at shoulder height. They were comparable to the forces in the handle at eye level and significantly lower than the forces in the handle located either lower or further away from the shoulder. Our results indicate that although the location of a supportive hand contact has no effect on the peak centre-of-pressure displacement of healthy individuals, it affects the forces that an individual needs to exert on the handle in order to counteract support perturbations.

The work was carried out in the scope of the FP7 project Codyco (<http://www.codyco.eu>) that aims to advance the current control and cognitive understanding of robust, goal-directed, whole-body, motion interaction with multiple contacts. The project goes beyond traditional approaches by proposing methodologies for performing coordinated interaction tasks with

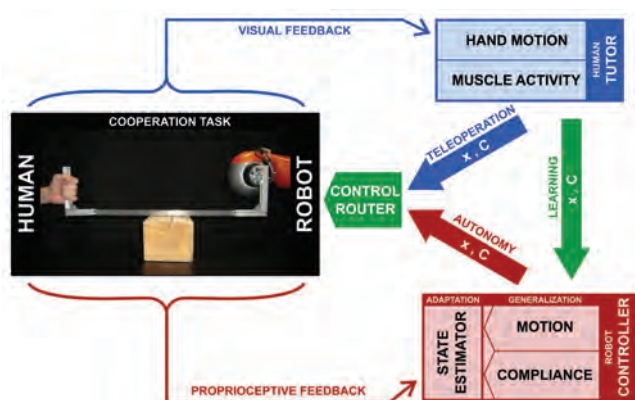


Figure 2: A method for teaching robots to cooperate with humans in dynamic manipulation tasks.

complex systems; by combining planning and compliance to deal with predictable and unpredictable events and contacts; and by validating theoretical advances in real-world interaction scenarios.

II. Humanoid and Cognitive Robotics Lab

The aim of the research Humanoid and Cognitive Robotics Lab is to create robots capable of helping people and interacting with them in natural environments. Since humanoids are similar to humans, it is much easier for people to interact with humanoids than with other types of robots. We therefore believe that cognitive humanoid robots are the key to the development of robot companions that can help people in their homes, which is one of the most important challenges for robotics research.

The Humanoid and Cognitive Robotics Lab is involved in a number of EU projects from the program “Cognitive Systems and Robotics”. Most of our work in 2013 was performed within the program group “Automation, robotics and biocybernetics”, and the FP-7 projects Xperience, IntellAct, and ACAT:

large-scale integrated project “Robots bootstrapped through learning from experience” (Xperience), which has 7 partners.

STREP project “Intelligent observation and execution of actions and manipulations” (ItellAct) with 6 partners.

STREP project “Learning and execution of action categories” (ACAT) with 6 partners.

A more detailed description of these projects follows below.

Xperience (<http://www.xperience.org/>)

Current artificial cognitive systems are limited with respect to the generative mechanisms which rely on prior knowledge are employed to predict the immediate future and are key in increasing the bandwidth and speed of cognitive development. The goal of Xperience is to demonstrate that state-of-the-art enactive systems can be significantly extended by using structural bootstrapping to generate new knowledge. This process is founded on explorative knowledge acquisition, and subsequently validated through experience-based generalization. In Xperience we are going to implement, adapt, and extend a complete robot system for automating introspective, predictive, and interactive understanding of actions and dynamic situations.

IntellAct (<http://intellact.eu/>)

In this project we address the problem of understanding and exploiting the meaning of manipulations in terms of objects, actions and their consequences for reproducing human actions with machines. This is in particular required for the interaction between humans and robots, in which the robot has to understand the human action and then transfer it to its own embodiment. IntellAct aims to provide the means to allow for this transfer, not by copying the movements of the human but by transferring the human action on different levels, including action semantics. We will demonstrate the ability to understand scene and action semantics and to execute actions with a robot in two domains: in a laboratory environment (exemplified by a lab on International Space Station) and in an assembly process in an industrial context.

ACAT (<http://www.acat-project.eu>)

This project focuses on the problem how artificial systems (robots) can understand and utilize the information made for humans. For this, ACAT generates a dynamic process memory by the extraction and storage of action categories from large bodies of human compatible sources (text, images). Action categories are designed to include the actual action-encoding, but also large amounts of context information (“background”). The ACAT system then uses action-categories to compile robot-executable plans. Execution benefits strongly from the rich context information present in the action-categories, which allows for generalization (for example, the replacement of objects in an action). It also permits us to specifically address the ambiguity, incompleteness and uncertainty in planning. Plans are grounded by perception and execution, which takes place with a robot. This leads to a life-long update process of the knowledge base.

The most important result of IntellAct in 2013 was the development of a new methodology for learning and the adaptation of manipulation skills that involve physical contact with the environment. Pure position control is

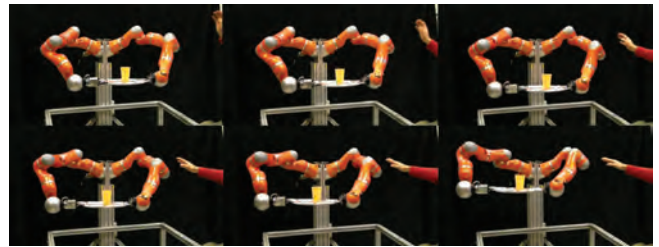


Figure 3: Two-arm robot holding a plate and avoiding the human moving into the robot's workspace.



Figure 4: An imitation learning system that can take into account forces and torques arising in tasks that involve contact with the environment.

In IntellAct we developed a new concept for the imitation learning which enables the consideration of forces and torques arising during the execution of the task. The developed technology is currently being transferred to industrial environments with an industrial partner.

unsuitable for such tasks because even small errors in the desired trajectory can cause significant deviations from the desired forces and torques. The proposed algorithm takes a reference Cartesian trajectory and the force/torque profile as the input and adapts the movement so that the resulting forces and torques match the reference profiles. Experimentally, we showed that the robot's performance can be significantly improved within a few iteration steps, compensating for vision and other errors that might arise during the execution of the task.

Among the important results of Xperience in 2013 was the development of a system that extends the framework of dynamic movement primitives with force/torque feedback, thereby bridging the gap from kinematic behaviours typically encoded by DMPs to dynamic behaviours. We proposed and evaluated a modulation approach that allows the interaction with objects and the environment. Through the proposed coupling of originally independent robotic trajectories, the approach also enables the execution of bimanual and tightly coupled cooperative tasks. We also proposed an approach for altering existing robot behaviours online, where a human coach interactively changes robot motion to achieve the desired outcome. Using hand gestures, the human coach can specify the desired modifications to the previously acquired behaviour. Another important line of research was how to improve visual object learning and recognition by exploiting the advantages of foveated vision. We showed that we can improve the performance of learning by using the manipulation capabilities of the robot and various resolutions of a foveated vision system.

In ACAT we are especially interested in Cartesian space representations of motor skills, as textual information usually refers to Cartesian space. We have therefore shown how dynamic movement primitives can be defined for non-minimal, singularity free representations of orientation, such as rotation matrices and quaternions. All of the advantages of DMPs, including ease of learning, the ability to include coupling terms, and scale and temporal invariance, can be adopted in our formulation. We have also proposed a new phase-stopping mechanism to ensure full movement reproduction in the case of perturbations.

Research in the area of humanoid and cognitive robotics is further conducted within a number of smaller projects supported by the Slovenian Research Agency and other international entities as well as with funding acquired in the frame of the young researchers program. In the frame of a bilateral project with ATR Computational Neuroscience Laboratories, Kyoto, Japan, funded by the Slovenian Research Agency and the Japan Society for the Promotion of Science, we performed a number of experiments in the area of humanoid robotics. All our projects focus on a better understanding of sensorimotor learning, visual processing, and lifelong learning in robotic systems, thus contributing to the overall vision of the group. We have published our results in prime robotics journals and at the most important robotics conferences, like Humanoids, IROS and ICRA, where we also organized two workshops in 2013.

III. Biocybernetics (Environmental Physiology and Ergonomics)

The biocybernetics group focuses primarily on research projects concerning the influence of extreme environmental factors on humans as well as the development and evaluation of technology and strategies to maintain safety and unhindered performance in such extreme environments.

Planetary Habitat Simulation (PlanHab)

The aim of this research program is to investigate the effect of a simulated planetary habitat environment on different human physiological systems. For technical reasons, the environment within future Lunar and Mars habitats will be hypobaric and hypoxic. Prolonged exposure to low gravity results in a deconditioning of vital physiological systems, and may consequently constitute a threat to the health of the astronauts. However, it is not known how prolonged exposure to both reduced gravity and hypoxia will affect health. For the purpose of this research programme we established a Planetary Habitat Simulation Facility at the Olympic Sport Centre Planica. The challenge of the project is in the complexity of the experimental interventions, whereby healthy humans are confined to a hypoxic environment during prolonged bedrest. Subjects have recently participated in three trials: hypoxic bedrest (simulated altitude 4000m), normoxic bedrest, and hypoxic ambulation. The effects of these interventions were investigated in experiments concerning metabolic, cardiorespiratory, musculoskeletal, haematological, immunological and thermoregulatory functions. We anticipate that the new knowledge gained from these studies will also have clinical implications, since chronic hypoxia and bedrest constitutes a model of the underlying chronic condition experienced by patients suffering from respiratory insufficiency, cardiac diseases and obesity.

A research program funded by the European Space Agency (ESA) Programme for European Cooperating States (PECS) and EU Framework program (FP7), which addresses the effects of longer exposure to combined inactivity/unloading and hypoxia have been successfully completed at the Olympic Sport Centre Planica.

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Central Sleep Apnea and Body Temperature Regulation in Normobaric versus Hypobaric Hypoxic Environments

Thus, aim of this study is to examine the acute and chronic effects of living at altitude on central sleep apnea, whether exposure to hypoxia will prevent the effective dilation of peripheral blood vessels in the evening, and whether these responses will delay the onset of sleep, ultimately affecting sleep quality and the likelihood of suffering mountain sickness or other adverse health outcomes. The results of this study will provide information for the assessment of clinical sleep function, particularly for populations with peripheral vascular disorders. The study is supported by the European Space Agency, and is being conducted at the Concordia Antarctic Research station situated at an altitude equivalent to approximately 4000 m at the equator. The results of the study will be compared to the results obtained in studies conducted at a similar simulated altitude at the Olympic Sport Centre Planica, but in normobaric hypoxic conditions. In this manner we will contribute to the evaluation of the Equivalent Air Altitude Theory.

Hypoxia and Metabolic health

The weight loss observed during prolonged sojourns at high altitude does not appear to be entirely due to an imbalance between energy intake and expenditure. The observation that high-altitude exposure may lead to considerable weight loss has led to the suggestion that it might be beneficial to incorporate hypoxic training in weight-management programs for obese individuals. Studies have demonstrated that mild physical exercise in normobaric hypoxia causes a significantly greater weight loss in obese people than exercise in placebo hypoxic environment. To our knowledge, no systematic studies have been carried out to date regarding the treatment of obesity and metabolic syndrom under hypoxic conditions. During prolonged sojourns to high altitude, factors which may contribute to weight loss include: dehydration, primary anorexia, lack of palatable food, detraining, and possibly direct effects of hypoxia on metabolism. We completed a series of studies, co-financed by Dutch industrial partner b-Cat, investigating the effect of 10-d sojourns in normobaric hypoxia, equivalent to a simulated altitude of 3200 m, on metabolism in combination with exercise training or without any activity. Specifically, the responses of plasma glucose, insulin, gut peptides, resting energy expenditure and satiety scores following a standard meal. Preliminary results indicate that one of the main contributors implicated in the observed weight loss is the elevated resting energy expenditure, and reduced appetite. Our current focus on this topic is the dose response to different levels of physical activity in hypoxia, coupled with an investigation of the effects of different hypoxic modalities on oxidative stress and cardiovascular health. In this regard we have established a collaboration with the Universities of Lausanne and Lyon.

Sleep architecture during hypoxic exposures

With colleagues from the Institute of Neurophysiology at University Clinical Centre Ljubljana we are investigating the effect of sleep architecture during prolonged exposure to hypoxia combined with different levels of activity. Research in this area is performed both under normobaric hypoxic conditions (Planica facility) and under hypobaric hypoxic conditions (Antarctic ESA research station). Our findings to date indicate that the main effect of hypoxia on sleep arise from changes in the frequency and magnitude of central sleep apnea.

Sleep temperature regulation

In addition to the polysomnographic recordings, we have also tested the theory that sleep onset is functionally linked with thermo-afferent feedback from cutaneous warm receptors. Our preliminary results confirm this theory, but have revealed that the hypoxia-induced vasoconstriction observed during the day disappears during the night. Thus our main studies in this area now focus on gaining a better understanding of this phenomenon through repeated measures and longitudinal designs.

Altitude retinopathy

Using a non-mydriatic fundus camera we have documented the diameter of retinal arterioles and venules at different stages of hypoxic exposure. Together with colleagues from the Eye Clinic at the University Clinical Centre, and the VITO Institute in Belgium we are currently analysing these scans to assess any hypoxia-induced vascular changes in the retina, which may be related to the onset of altitude retinopathy.

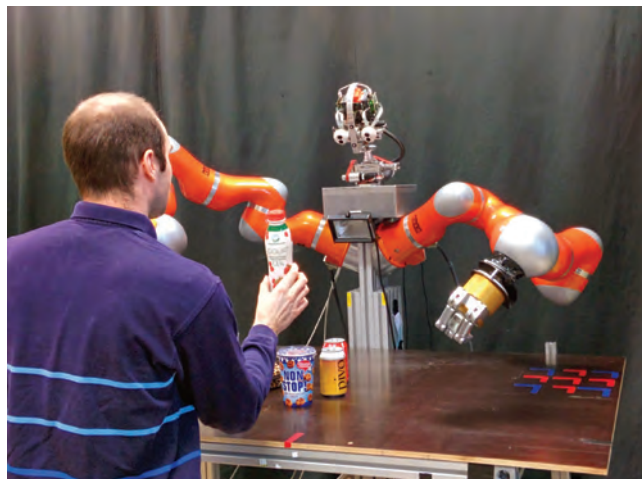


Figure 5: Humanoid head used in experiments on object learning by manipulation and foveated vision.

Field studies

In addition to our laboratory investigations, we continue to collaborate with high altitude Slovenian expeditions as well as with a number of national sport teams, assisting with their preparations and monitoring the effects of the high altitude exposures or altitude training regimens on various physiological systems and performance.

Development of diagnostic tool for determining susceptibility to freezing cold injury

In Slovenia, the main risk group for cold injury are alpinists participating in high-altitude expeditions. In collaboration with researchers from the Royal Institute of Technology (Stockholm, Sweden), we are running a research program, with two specific aims: i) to develop a diagnostic method to determine the susceptibility of individuals to cold injury; ii) to develop a training program to improve an individual's vascular response to a cold stimulus, thus

minimizing one's risk to cold injury. A series of laboratory and field studies have been conducted, examining the digit vascular response to cold-water immersion (cold-induced vasodilatation, CIVD), and the pattern of digit reperfusion following cold exposure using infrared thermography. We are currently evaluating the effect of several training programs, in terms of their effect on the CIVD response.



Figure 6: We are coordinating the research programme HASTE (Hypoxia: Altitude, Sleep & Temperature in Extreme Environments: Central sleep apnea and body temperature regulation in normobaric versus hypobaric hypoxic environments), supported by the European Space Agency (ESA), at the Antarctic research station Concordia

Evaluation of protective clothing (Desert Ensembles)

Soldiers on peacekeeping missions in desert regions must be able to sustain prolonged exposures to hot (45°C) and dry (10% relative humidity) environments, all while dressed in full combat gear. Our research program initially focused on the physiological responses of soldiers carrying loads in such environments. We have continued our work in this area, and have evaluated the efficacy of different technologies (i.e., ventilated vests) and/or strategies (i.e., work/rest schedules) in minimizing heat strain and improving performance in such environments. Together with colleagues from the Royal Institute of Technology we have continued this work to assess the impact of the next-to-skin layer on the thermal balance of soldiers in such environments. In addition, we have also investigated the effect of moisture content of the next-to-skin layer on predicted burn injuries during a simulated flash fire. With an industrial partner Lenzing (Austria) we have demonstrated that

increased moisture content of the next-to-skin layer provides added protection against burn injury. We are continuing our analysis to determine under what conditions the microenvironment moisture may lead to a scalding injury.

Thermal and nonthermal factors affecting exercise tolerance in the heat

Based on the Marie Curie IRSES grant on the "International cooperation for the advancement of research on the underlying systems of human thermoregulation" we initiated a research collaboration with the University of Cape Town. The project aims at advancing the current understanding of physiological responses to thermal stress and the main underlying mechanisms. The exchange of researchers between the two institutions allows for a significant transfer of knowledge, experimental techniques and ideas between the laboratories.

Some outstanding publications in the past three years

1. Petrič, T., Gams, A., Babič, J., Žlajpah, L.: Reflexive stability control framework for humanoid robots. *Autonomous robots*, 2013, vol. 34, no. 4, 347–361
2. Peternel, L., Babič, J.: Learning of compliant human robot interaction using full-body haptic interface. *Advanced robotics*, vol. 27, no. 3, 2013
3. Gams, A., Petrič, T., Debevec, T., Babič, J.: Effects of robotic knee exoskeleton on human energy expenditure. *IEEE transactions on bio-medical engineering*, ISSN 0018-9294, 2013, vol. 60, no. 6, 1636–1644
4. Schiebener, D., Morimoto, J., Asfour, T., Ude, A.: Integrating visual perception and manipulation for autonomous learning of object representations, *Adaptive Behavior*, vol. 21, no. 5, 328–345 (2013)
5. Forte, D., Gams, A., Morimoto, J., Ude, A.: On-line motion synthesis and adaptation using a trajectory database, *Robotics and Autonomous Systems*, vol. 60, no. 10, 1327–1339 (2012)
6. Debevec, T., Pialoux, V., Mekjavic, I. B., Eiken, O., Murry, P., Millet, G. P.: Moderate exercise blunts oxidative stress induced by normobaric hypoxic confinement. *Medicine and science in sports and exercise*, ISSN 0195-9131, 2014, vol. 46, no. 1, 33–41

Debevec, T., McDonnell, A., Macdonald, I., Eiken, O., Mekjavić, I. B.: Whole body and regional body composition changes following 10-day hypoxic confinement and unloading/inactivity. *Applied physiology, nutrition and metabolism*, ISSN 1715-5312, [in press] 2013

Awards and appointments

1. Marjeta Kramar Fijavž: Best University Teacher Award at Department of Civil Engineering, University of Ljubljana, Faculty of Civil and Geodetic Engineering, awarded by the Student Council of the Faculty, Ljubljana, December 2013

Organization of conferences, congresses and meetings

1. The 22nd International Workshop on Robotics in Alpe-Adria-Danube Region RAAD 2013, Portorož, Slovenia, 11.-13. 9. 2013
2. IntellAct Meeting, Ljubljana, Slovenia, 9. 9. 2013

Patent granted

1. Igor Kovač, Borut Lenart, Bojan Nemeč, Marko Scortegagna, Leon Žlajpah, Humanoid torso mechanism, SI24099 (A), Urad RS za intelektualno lastnino, 31.12.2013.

INTERNATIONAL PROJECTS

1. Stimulators and Parts
Foreign Buyers
Asst. Prof. Aleš Ude
2. 7FP - IntellAct; Intelligent Observation and Execution of Actions and Manipulation
European Commission
Asst. Prof. Aleš Ude
3. 7FP - Xperience; Robots Bootstrapped through Learning from Experience
European Commission
Asst. Prof. Aleš Ude
4. 7FP - ACAT; Learning and Execution of Action Categories
European Commission
Asst. Prof. Aleš Ude
5. 7FP - CoDyCo; Whole-body Compliant Dynamical Contacts in Cognitive Humanoids
European Commission
Asst. Prof. Jan Babič
6. 7FP - ICARUS; International Cooperation for the Advancement of Researcher on the Undelaying System of Human Thermoregulation
European Commission
Prof. Igor Mekjavić
7. 7FP - PlanHab; Planetary Habitat Simulation
European Commission
Prof. Igor Mekjavić
8. Accelerated Development of Autonomous Behaviors for Humanoid Robots
Slovenian Research Agency
Asst. Prof. Aleš Ude

RESEARCH PROGRAM

1. Avtomation, Robotics and Biocybernetics
Prof. Igor Mekjavić

R&D GRANTS AND CONTRACTS

1. Dual Nature of Stem Cells in Cancer and Their Application in Therapy
Prof. Igor Mekjavić
2. Learning, Analysis, and Detection of Motion in the Framework of a Hierarchical Compositional Visual Architecture
Asst. Prof. Aleš Ude
3. The Role of Small GTPases in the Regulation of Endosomal/Lysosomal Transport in Astrocytes
Prof. Igor Mekjavić
4. The Detection of Irregularities and Fraud in the Financing of the Public Health Services
Dr. Marjeta Kramar Fijavž
5. Development of a New Generation of Thermal Manikin for Evaluation of Personal Protective Equipment and Safety of Health in Extreme Working and Living Environmental Conditions (X-Termoman)
Prof. Igor Mekjavić
6. Influence of Ski Width on Alpine Skiing Safety
Asst. Prof. Bojan Nemeč
7. Zero and Reduced Gravity Simulation: The Effect on the Cardiovascular and Musculoskeletal Systems
Prof. Igor Mekjavić
8. Hypoxic Inactivity: Implications for Heart Failure, Respiratory Insufficiency and Obesity
Prof. Igor Mekjavić
9. On-line Learning and Adaptation of Robot Skills to the Demonstrated Force Profiles
Asst. Prof. Aleš Ude

NEW CONTRACT

1. Monitoring Foot Growth in Children
UCS - Universal Customization System, d. o. o.
Prof. Igor Mekjavić

VISITORS FROM ABROAD

1. Dr. Simon Hangl, University of Innsbruck, Austria, 7.-11. 1. 2013
2. Paul Canatella, Biran McAdams, W. L. Gore & Associates, Inc., Elkton, Maryland, USA, 12.-14. 1. 2013
3. Nora Beck Tan, W. L. Gore & Associates, Inc., Elkton, Maryland, USA, 13.-14. 1. 2013
4. Sabrina Langenmaier, W. L. Gore & Associates, Feldkirchen, Germany, 13.-14. 1. 2013
5. Dr. Tarsi Bali, University of Athens, Greece, 17. 2.-6. 4. 2013
6. Anders Glent Buckt, BSc, SDU Odense, Denmark, 20.-22. 3. 2013
7. Dr. Nathalie Pattyn, Helio Fernandez, University of Brussels, Belgium, 17.-20. 4. 2013
8. Ksavier Neyt, University of Brussels, Belgium, 17. 4.-4. 5. 2013
9. Dr. Stylianos Kounalakis, University of Athens, Greece, 3. 5.-10. 5. 2013
10. Dr. Marietta Konstantonpoulo, Clinical Centre in Patras, Greece, 3.-10. 5. 2013
11. Prof. Sang- Ho Hyon, University of Ritsumeikan, Kyoto, Japan, 11.-14. 5. 2013
12. Shingo Ando, Masaru Adachi and Yukio Nose, Yashawa, Japan, 13.- 15. 5. 2013
13. Dr. Jun Morimoto, Dr. Sang-Ho Hyon, Dr. Norikazu Sugimoto, 11.-15. 5. 2013
14. Dr. Tomoyuki Noda, ATR Computational Neuroscience Laboratories, Kyoto, Japan, 11.- 15. 5. 2013
15. Dr. Emre Ugur, University of Innsbruck, Austria, 13.-15. 6. 2013
16. Dr. Elske Schabort, University of Cape Town, South Africa, 21. 7.-5. 8. 2013
17. Dr. I-Ming Chen, Nanyang Technological University, Singapore, 13.-14. 9. 2013
18. Dr. Norbert Krüger, SDU Odense, Denmark, 12.-13. 9. 2013
19. Dr. Emre Ugur, University of Innsbruck, Austria, 13.-14. 9. 2013
20. Dr. Andreas Holzbach, TU Munich, Germany, 16.-27. 9. 2013
21. Prof. Aleš Leonardis, University of Birmingham, United Kingdom, 30. 9. 2013
22. Prof. Hiroshi Ishiguro, ATR Kyoto, Japan, 11. 10. 2013

23. Prof. Henrik Sharfe, University of Aalborgu, Denmark, 11. 10. 2013
 24. Shingo Ando, Yaskawa, Japan, 25. 10. 2013
 25. Dr. Michael Mistry, University of Birmingham, United Kingdom, 14.-17. 11. 2013

26. Dr. Fares Abu-Dakka, University of Madrid, Spain, 4.-14. 12. 2013
 27. Prof. Vincenzo Parenti-Castelli with students, University of Bologna, Italy, 23. 12. 2013

STAFF

Researchers

1. Asst. Prof. Jan Babič
2. Dr. Andrej Gams
3. Asst. Prof. Igor Kovač
4. Prof. Igor Mekjavič
5. Asst. Prof. Bojan Nemeč
6. Dr. Anton Ružič
7. Asst. Prof. Aleš Ude
8. **Asst. Prof. Leon Žlajpah, Head**

Postdoctoral associates

9. *Dr. Fares Jawad Mohd Abu-Dakka, left 24.10.13*
10. Dr. Tarsi Bali
11. Asst. Prof. Gregor Cigler*
12. Dr. Tadej Debevec
13. Dr. Denis Forte
14. Prof. Igor Klep
15. Asst. Prof. Marjeta Kramar Fijavž*
16. *Dr. Shawnda Morrison, left 01.12.13*
17. Dr. Tadej Petrič
18. *Dr. Janez Šter, left 01.10.13*

Postgraduates

19. Robert Bevec, B. Sc.

20. Miha Deniša, B. Sc.
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30. Tanja Dragojevič, B. Sc.
31. Dušan Filipič
32. Damjan Fink
33. Marija Kavčič, B. Sc.
34. *Matjaž Kocuvan, died 04.12.13*
35. Jana Stanič

Note:

* part-time JSI member

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Fares Abu Dakka, Francisco Rubio, Francisco Valero, Vicente Mata, "Evolutionary indirect approach to solving trajectory planning problem for industrial robots operating in workspaces with obstacles", *Eur. j. mech. A, Solids*, vol. 42, pp. 210-218, 2013.
2. Fatih Bayazit, Britta Dorn, Marjeta Kramar Fijavž, "Asymptotic periodicity of flows in time-depending networks", *Netw. heterog. media*, vol. 8, issue 4, pp. 843-855, 2013.
3. Gregor Cigler, Roman Drnovšek, "On semigroups of matrices with nonnegative diagonals", *Linear algebra appl.*, vol. 438, iss. 1, pp. 626-633, 2013.
4. Andrej Gams, Tadej Petrič, Tadej Debevec, Jan Babič, "Effects of robotic knee exoskeleton on human energy expenditure", *IEEE trans. biomed. eng.*, vol. 60, no. 6, pp. 1636-1644, 2013.
5. Paola Iovino, Giuseppe Chiarioni, Giancarlo Bilancio, Massimo Cirillo, Igor B. Mekjavič, Rado Pišot, Carolina Ciacci, "New onset of constipation during long-term physical inactivity: a proof-of-concept study on the immobility-induced bowel changes", *PLoS one*, vol. 8, iss. 8, pp. 1-8, 2013.
6. Michail E. Keramidias, Nickos D. Geladas, Igor B. Mekjavič, Stylianos N. Kounalakis, "Forearm-finger skin temperature gradient as an index of cutaneous perfusion during steady-state exercise", *Clin. physiol. funct. imaging*, vol. 33, no. 5, pp. 400-404, 2013.
7. Roger Kölegård, Igor B. Mekjavič, Ola Eiken, "Effects of physical fitness on relaxed G-tolerance and the exercise pressor response", *Eur. j. appl. physiol.*, vol. 113, no. 11, pp. 2749-2759, 2013.
8. Stylianos N. Kounalakis, Michail E. Keramidias, Ola Eiken, Polona Jaki, Igor B. Mekjavič, "Peak oxygen uptake and regional oxygenation in response to a 10-day confinement to normobaric hypoxia", *Scandinavian journal of medicine & science in sports*, vol. 34, no. 4, pp. e233-e245, 2013.
9. Igor B. Mekjavič, Uroš Dobnikar, Stylianos N. Kounalakis, "Cold-induced vasodilation response in the fingers at four different water temperatures", *Applied physiology, nutrition and metabolism*, vol. 38, no. 1, pp. 14-20, 2013.
10. Shawnda A. Morrison, Stephen S. Cheung, Roger D. Hurst, James D. Cotter, "Cognitive function and blood-brain barrier permeability during exercise in the heat: effect of fitness and bovine colostrum supplementation", *J. therm. biol.*, vol. 38, no. 7, pp. 374-383, 2013.
11. Bojan Nemeč, Rok Vuga, Aleš Ude, "Efficient sensorimotor learning from multiple demonstrations", In: Proceedings of the 21th International Workshop on Robotics in Alpe-Adria-Danube Region, 10-13 September 2012, Naples, Italy, *Adv. Robot.*, vol. 27, no. 13, pp. 1023-1031, 2013.
12. Luka Peternel, Jan Babič, "Learning of compliant humanrobot interaction using full-body haptic interface", In: Proceedings of the 21th International Workshop on Robotics in Alpe-Adria-Danube Region, 10-13 September 2012, Naples, Italy, *Adv. Robot.*, vol. 27, no. 13, pp. 1003-1012, 2013.
13. Tadej Petrič, Andrej Gams, Jan Babič, Leon Žlajpah, "Reflexive stability control framework for humanoid robots", *Auton. robots*, vol. 34, no. 4, pp. 347-361, 2013.
14. Tadej Petrič, Andrej Gams, Tadej Debevec, Leon Žlajpah, Jan Babič, "Control approaches for robotic knee exoskeleton and their effects on human motion", In: Proceedings of the 21th International Workshop on Robotics in Alpe-Adria-Danube Region, 10-13 September 2012, Naples, Italy, *Adv. Robot.*, vol. 27, no. 13, pp. 993-1002, 2013.
15. Tadej Petrič, Leon Žlajpah, "Smooth continuous transition between tasks on a kinematic control level: obstacle avoidance as a control problem", *Robot. auton. syst.*, vol. 61, no. 9, pp. 948-959, sep. 2013.
16. David Schiebener, Jun Morimoto, Tamim Asfour, Aleš Ude, "Integrating visual perception and manipulation for autonomous learning of object representations", *Adapt. behav.*, no. 21, no. 5, pp. 328-345, 2013.
17. Mitja Slavinec, Daniela Zavec Pavlinič, Robert Repnik, Nejc Duh, Igor B. Mekjavič, "Istraživanje udobnosti odječe fizikalnom analizom i pomoću "termo odijela"", *Tekstil*, vol. 62, no. 9/10, pp.361-369, 2013.
18. Matej Supej, L. Sætran, Lucca Oggiano, Gertjan Ettema, Nejc Šarabon, Bojan Nemeč, Hans-Christer Holmberg, "Aerodynamic drag is not the major determinant of performance during giant slalom skiing at the elite level", *Scandinavian journal of medicine & science in sports*, vol. 23, no. 1, pp. e38-e47, 2013.
19. Janez Šter, "Lifting units in clean rings", *J. algebra*, vol. 381, pp. 200-208, 2013.
20. Michael J. Tipton, Hitoshi Wakabayashi, Martin Barwood, Clare Eglin, Igor B. Mekjavič, Nigel A. S. Taylor, "Habituation of the metabolic and ventilatory responses to cold-water immersion inhumans", *J. therm. biol.*, vol. 38, no. 1, pp. 24-31, 2013.

21. Florentin Wörgötter, Eren Erdal Aksoy, Norbert Krüger, Justus Piater, Aleš Ude, Minija Tamošunaitė, "A simple ontology of manipulation actions based on hand-object relations", *IEEE trans. auton. ment. dev.*, vol. 5, no. 2, pp. 117-134, 2013.
22. Daniela Zavec Pavlinič, Anica Hursa Šajatović, Igor B. Mekjavić, "Suvremeni koncept testiranja protupožarne zaštite odječe", *Sigurnost*, vol. 55, no. 2, pp. 97- 106, 2013.

REVIEW ARTICLE

1. Giancarlo Bilancio, Cinzia Lombardi, Rado Pišot, Igor B. Mekjavić, Natale Gaspare De Santo, Maria Grazia Luciano, "Effects of prolonged immobilization on sequential changes in mineral and bone disease parameters: to the editor", *Am J Kidney Dis*, vol. 61, no. 5, pp. 845-847, 2013.
2. Tadej Debevec, Igor B. Mekjavić, "Short intermittent hypoxia for improvement of athletic performance: reality or a placebo?: realnost ali placebo?", *Kinesiol. Slov.*, vol. 19, no. 3, pp. 5-28, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Mohamad Javad Aein, Eren Erdal Aksoy, Minija Tamošunaitė, Jeremie Papon, Aleš Ude, Florentin Wörgötter, "Toward a library of manipulation actions based on semantic object-action relations", In: *IROS2013: New horizon*, 2013/IEEE/RSJ International Conference on Intelligent Robots and Systems, November 3-8, 2013, Tokyo, Japan, Danvers, IEEE = Institute of Electrical and Electronics Engineers, 2013, pp. 4555-4562.
2. Eren Erdal Aksoy, Minija Tamošunaitė, Rok Vuga, Aleš Ude, Christopher Geib, Florentin Wörgötter, "Structural bootstrapping at the sensorimotor level for the fast acquisition of action knowledge for cognitive robots", In: *2013 IEEE Third Joint International Conference on Development and Learning and Epigenetic Robotics (ICDL)*, 18-22 August 2013, Osaka, Japan, 2013 IEEE Third Joint International Conference on Development and Learning and Epigenetic Robotics (ICDL), 18-22 August 2013, Osaka, Japan, Danvers, IEEE = Institute of Electrical and Electronics Engineers, 8 pp..
3. Robert Bevec, Aleš Ude, "Object learning through interactive manipulation and foveated vision", In: *HUMANOIDS 2013*, IEEE-RAS International Conference on Humanoid Robots, October 15 -17, 2013, Atlanta, Georgia, USA, Danvers, IEEE, 2013, pp. 234-239.
4. Helena Chowdhury Haque, Jelena Velebit Marković, Nataša Radić, Vito Frančič, Igor B. Mekjavić, Ola Eiken, Robert Zorec, "A new approach to study properties of isolated preadipocytes following in vivo exposure to hypoxia", In: *Proceedings of Life in space for life on earth, 18-22 June 2012, Aberdeen*, (ESA SP (CD-ROM)), L. Ouwehand, ed., Noordwijk, ESA Communications, 2013.
5. Miha Deniša, Tadej Petrič, Tamim Asfour, Aleš Ude, "Synthesizing compliant reaching movements by searching a database of example trajectories", In: *HUMANOIDS 2013*, IEEE-RAS International Conference on Humanoid Robots, October 15 -17, 2013, Atlanta, Georgia, USA, Danvers, IEEE, 2013, pp. 540-546.
6. Miha Deniša, Aleš Ude, "New motor primitives through graph search, interpolation and generalization", V: *Frontiers of intelligent autonomous systems: Iselected papers from the 12th International Conference on Intelligent Autonomous Systems (IAS-12)*, Jeju, Korea, June 26-29, 2012], (Studies in computational intelligence, 466), Sukhan Lee, ur., Kwang Y. Lee, ur., Jangmyung Lee, ur., Heidelberg, New York, Springer, cop. 2013, str. 137-148.
7. Andrej Gams, Jesse van den Kiebooma, Florin Dzeladini, Auke Jan Ijspeert, "Stable real-time full body motion imitation on the COMAN humanoid robot", In: *Proceedings*, 22nd International Workshop on Robotics in Alpe-Adria-Danube Region [also] RAAD 2013, September 11-13, Portorož, Slovenia, Bojan Nemeč, ed., Leon Žlajpah, ed., 1st ed., Ljubljana, Jožef Stefan Institute, 2013, pp. 25-32.
8. Andrej Gams, Bojan Nemeč, Leon Žlajpah, Mirko Waechter, Auke Jan Ijspeert, Tamim Asfour, Aleš Ude, "Modulation of motor primitives using force feedback: interaction with the Environment and Bimanual Tasks", In: *IROS2013: New horizon*, 2013/IEEE/RSJ International Conference on Intelligent Robots and Systems, November 3-8, 2013, Tokyo, Japan, Danvers, IEEE = Institute of Electrical and Electronics Engineers, 2013, pp. 5629-5635.
9. Adam McDonnell, Igor B. Mekjavić, Leja Dolenc-Grošelj, Polona Jaki, Ola Eiken, "Effect of hypoxia and bedrest on peripheral vasoconstriction", In: *Proceedings of Life in space for life on earth, 18-22 June 2012, Aberdeen*, (ESA SP (CD-ROM)), L. Ouwehand, ed., Noordwijk, ESA Communications, 2013, 2 pp.

10. Bojan Nemeč, Fares Abu Dakka, Barry Ridge, Aleš Ude, Jimmy A. Jørgensen, Thijs R. Savarimuthu, Henrik G. Petersen, Jerome Jouffroy, Norbert Krüger, "Transfer of assembly operations to new workplace poses by adaptation to the desired force profile", In: *ICAR 2013*, 16th International Conference on Advanced Robotics, November 25th to 29th 2013, Montevideo, Uruguay, [S., s. n.], 2013, 7 pp.
11. Bojan Nemeč, Andrej Gams, Aleš Ude, "Velocity adaptation for self-improvement of skills learned from user demonstrations", In: *HUMANOIDS 2013*, IEEE-RAS International Conference on Humanoid Robots, October 15 -17, 2013, Atlanta, Georgia, USA, Danvers, IEEE, 2013, pp. 423-428.
12. Luka Peternel, Jan Babič, "Humanoid robot posture-control learning in real-time based on human sensorimotor learning ability", In: *ICRA 2013*, 2013 IEEE International Conference on Robotics and Automation, May 6-10, 2013 Karlsruhe, Germany, [S. l.], IEEE, cop. 2013, pp. 5309-5314.
13. Tadej Petrič, Leon Žlajpah, Gianluca Garofalo, Christian Ott, "Walking control using adaptive oscillators combined with dynamic movement primitives", In: *Proceedings*, 22nd International Workshop on Robotics in Alpe-Adria-Danube Region [also] RAAD 2013, September 11-13, Portorož, Slovenia, Bojan Nemeč, ed., Leon Žlajpah, ed., 1st ed., Ljubljana, Jožef Stefan Institute, 2013, pp. 204-211.
14. Barry Ridge, Aleš Ude, "Action-grounded push affordance bootstrapping of unknown objects", In: *IROS2013: New horizon*, 2013/IEEE/RSJ International Conference on Intelligent Robots and Systems, November 3-8, 2013, Tokyo, Japan, Danvers, IEEE = Institute of Electrical and Electronics Engineers, 2013, pp. 2791-2798.
15. T. R. Savarimuthu, D. Liljekrans, L. -P. Ellekilde, Aleš Ude, Bojan Nemeč, Norbert Krüger, "Analysis of human peg-in-hole executions in a robotic embodiment using uncertain grasps", In: *Workshop proceedings*, 2013 IEEE Third Joint International Conference on Development and Learning and Epigenetic Robotics (ICDL), 18-22 August 2013, Osaka, Japan, Danvers, IEEE = Institute of Electrical and Electronics Engineers, pp. 233-239.
16. Nektarios Stavrou, Adam McDonnell, Ola Eiken, Igor B. Mekjavić, "Indices of psychological strain during hypoxic bedrest confinement", In: *Proceedings of Life in space for life on earth, 18-22 June 2012, Aberdeen*, (ESA SP (CD-ROM)), L. Ouwehand, ed., Noordwijk, ESA Communications, 2013, 2 pp.
17. Boštjan Šimunič, H. Degens, Joern Rittweger, Marco Narici, Venčeslav Pišot, Igor B. Mekjavić, Rado Pišot, "Tensiomyographic measurement of atrophy related processes during bed rest and recovery", In: *Proceedings of Life in space for life on earth, 18-22 June 2012, Aberdeen*, (ESA SP (CD-ROM)), L. Ouwehand, ed., Noordwijk, ESA Communications, 2013.
18. Rok Vuga, Eren Erdal Aksoy, Florentin Wörgötter, Aleš Ude, "Augmenting semantic event chains with trajectory information for learning and recognition of manipulation tasks", In: *Proceedings*, 22nd International Workshop on Robotics in Alpe-Adria-Danube Region [also] RAAD 2013, September 11-13, Portorož, Slovenia, Bojan Nemeč, ed., Leon Žlajpah, ed., 1st ed., Ljubljana, Jožef Stefan Institute, 2013, pp. 57-63.
19. Rok Vuga, Matjaž Ogrinc, Andrej Gams, Tadej Petrič, Norizaku Sugimoto, Aleš Ude, Jun Morimoto, "Motion capture and reinforcement learning of dynamically stable humanoid movement primitives", In: *ICRA 2013*, 2013 IEEE International Conference on Robotics and Automation, May 6-10, 2013 Karlsruhe, Germany, [S. l.], IEEE, cop. 2013, pp. 5264-5270.
20. Leon Žlajpah, "Multi-task control for redundant robots using prioritized damped least-squares inverse kinematics", In: *Proceedings*, 22nd International Workshop on Robotics in Alpe-Adria-Danube Region [also] RAAD 2013, September 11-13, Portorož, Slovenia, Bojan Nemeč, ed., Leon Žlajpah, ed., 1st ed., Ljubljana, Jožef Stefan Institute, 2013, pp. 311-318.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Đani Juričić, Matej Gašperin, Bojan Musizza, Gregor Dolanc, Igor B. Mekjavić, "A system for model-based quality assessment of burn-protective garments", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričić, ed., London [etc.], Springer, 2013, pp. 257-285.

PATENT APPLICATION

1. Igor Kovač, Borut Lenart, Bojan Nemeč, Marko Scortegagna, Leon Žlajpah, *Humanoid torso mechanism*, EP2676776 (A1), European Patent Office, 25.12.2013.

PATENT

1. Igor Kovač, Borut Lenart, Bojan Nemeč, Marko Scortegagna, Leon Žlajpah, *Humanoid torso mechanism*, SI24099 (A), Urad RS za intelektualno lastnino, 31.12.2013.

MENTORING

1. Denis Forte, *Generalization of libraries of robot movements using statistical methods*: doctoral dissertation, Ljubljana, 2013 (mentor Aleš Ude).
2. Miroljub Jakovljević, *Effect of inert gases on thermal stimuli sensation*: doctoral dissertation, Ljubljana, 2013 (mentor Igor B. Mekjavić).
3. Tadej Petrič, *Advanced robot control using adaptive oscillators*: doctoral dissertation, Ljubljana, 2013 (mentor Leon Žlajpah).
4. Janez Šter, *Clean rings and rings with the exchange property*: doctoral dissertation, Ljubljana, 2013 (mentor Matjaž Omladič).

DEPARTMENT OF SYSTEMS AND CONTROL

E-2

The department is engaged in the analysis, control and optimization of systems and processes. The activities of the department are focused on the research of new methods and algorithms for automatic control, the development of procedures and tools to support the design and construction of control systems, the development of specific measurement and control modules, and the development and construction of complete systems for the control and supervision of machines, devices and industrial processes.

Basic and applied research

The basic and applied research in 2013 was devoted to three sub-areas: methodologies for analysis and control systems design; tools and building blocks for implementation; and applied research in the priority problem domains.

The sub-area *methodologies for analysis and control systems design* included three topics.

The first topic addressed modeling and identification of nonlinear and complex dynamical systems. The research in the dynamic systems modelling of Gaussian process models was directed towards the on-line training and application of the on-line training for on-line control. The identification of Gaussian process models was used for the modelling of biological and environmental systems (Figure 1). A key feature of modern condition monitoring systems is the ability to predict the remaining useful life of the system or its components. To achieve this, we focus on the development of system identification algorithms for model-based prognostics and health management (PHM). We have developed a prognostics algorithm, which merges a sequential Monte-Carlo approach with a classical Kalman filter. The algorithm was applied to predict failures in both mechanical and electro-chemical systems.

The second topic was *advanced control*. We have continued the development and robustification of methods for the implementation of the simplified parametric predictive controller in practical control applications. We have implemented an improvement of a cascade scheme of magnetic plasma control for the Iter fusion tokamak reactor, where an additional feedback loop in charge of returning the vertical plasma position to the origin was introduced between the inner loop of vertical stabilisation and the outer loop of plasma current and shape control.

The third topic of interest was *condition monitoring and fault diagnosis*. Research in the area of condition monitoring has resulted in novel approaches to the robust diagnosis and prognosis of rotational machines and drives under incomplete information about variable operating conditions. The problem is notoriously difficult and relevant for practice. New results rely on the stochastic modelling of structural excitations that emerge from complex interactions between rotating and stationary parts by means of point processes. In addition, a new algorithm for detecting distributed faults in bearings from vibrational recordings has been developed. The solution to this nontrivial problem is applicable to the faults due to, e.g., electro-erosion in bearings. The most notable contribution in the area is related to the completed experimental prototype of a diagnostic and prognostic platform for rotational machines and successful implementation on three different industrial sites in Slovenia and abroad (Figure 2). The platform relies on an innovative holistic concept of the distributed sensor network, which allows for partial local signal processing, data fusion from different sensors, self-tuning of decision thresholds, remote configuration as well as integration with other information systems in the enterprise.

In the area tools and building blocks for implementation the MAGICS methodology for the development and automatic generation of process control software has been further developed. An experimental industrial prototype of an environment for this methodology has been developed, which supports the industrial practice of modelling and, partly, the automatic generation of the procedural part of the software for demanding process control systems.

In the field of production control, we were developing a software tool named ProOpter that enables the analysis of production dynamics using advanced methods like data mining, data reduction, determination of relevant manipu-



Head:

Dr. Vladimir Jovan

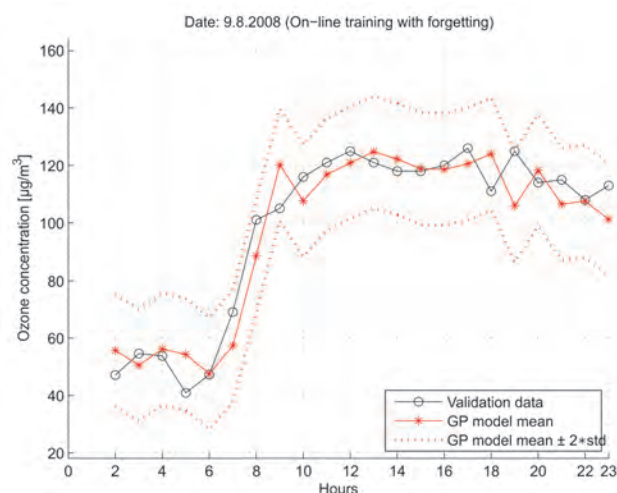


Figure 1: The predicted mean value and 95% confidence interval of ozone concentration for 9 August 2008 from GP model

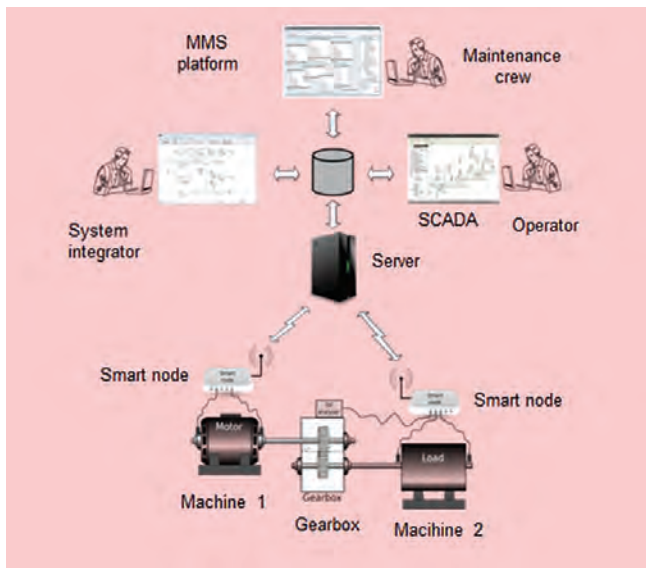


Figure 2: Scheme of the prototype of diagnostics & prognostics platform

lated variables and production performance indicators model identification (Figure 3). The obtained models enable the prediction and optimization of the production dynamics.

A reliable estimate of the remaining useful life is getting to be one of the most significant requirements in modern maintenance. We continued our research of a class of data-driven methods that rely on stochastic models derived from run-to-failure experiments performed on an appropriate set of similar items of equipment. A method employing entropy indices calculated from vibrational records has been further improved. Dynamic relations between indices and time-to-failure are described by Gaussian Process Models with truncated Gaussian distributions, which results in efficient new algorithms.

In 2013 we continued working on the diagnostics of PEM fuel cells with the use of impedance measurements. The main focus was on a procedure for collecting the impedance information. In this manner we developed a procedure for the estimation of the instantaneous PEM fuel-cell impedance, which is based on PRBS perturbation signals and the continuous wavelet transform. The procedure provides the means for an approximately five-times faster estimation of the impedance compared to conventional approaches.

In the area of fuel-cell models development the main objective was to build a Matlab/Simulink model of the HyPM[®] HD 8-200 Fuel-cell-based

power unit, purposed for testing control approaches and the optimization of power management. In the model, a combination of the use of the measured static characteristics and tuning of the physical equations that describe processes in the FC stack, as well as the Balance of Plant (BoP) components (blower, pumps, etc.) in the system. During this year the model has been extended with the stack temperature influence to internal resistance and output voltage. In parallel a load study and the assessment of battery choice for a FC-based APU has been made.

Applied research in the priority problem domains was the third sub-area of our interest. In this frame a substantial part of our activities was devoted to the development of the specific control systems described below.

In the frame of the Slovenian Research Agency's project on energy optimisation, new dynamic models of chillers for the purpose of energy consumption optimisation have been developed.

Control of wastewater treatment plants is our traditional research area. In cooperation with the company Kolektor Sinabit d.o.o., in 2013 we have developed a feed rate control of the anaerobic reactor for organic waste removal and biogas production. The proposed control adjusts the feed rate of the substrate based on measurements of the volatile fatty acids and acetate in the reactor. The control enables stable biogas production and prevents acidification of the process. Control was tested on the anaerobic reactor pilot plant.

In the frame of the Eurostars project ProDISMon we started with the development of algorithms aimed to improve the reliability of distributed condition monitoring systems by means of an on-line assessment of the quality of the acquired data as well as the fusion of data from various sensory inputs.

In recent years, a part of our work was focused on the area of *fuel cells*.

In 2011 we started cooperation on the 7th European project *FCGEN-Fuel Cell Based On-board Power Generation*. The objective of the FCGEN project is the development and demonstration of an auxiliary power unit (APU) for trucks, which uses an auto-thermal reformer to produce hydrogen from fuel and a fuel-cell stack for the electric energy production. In 2013 most of the process reactors for diesel conversion and reformate clean-up have been built and tested. Our group had two main work tasks. First, was the development of the complete APU control system and second was the development of the APU power-conditioning components. For the control system first the PLC version and HMI were finalized, and partially tested during the reactor tests. During the second half of the year the focus was on the development of the main controller, APU ECU, and the transfer of the control code from the PLC to the embedded controller. Within the power-conditioning task the prototype of the DC/DC converter and the power supply for the BoP component has been developed, built and tested.

Within the second 7th European project *FluMaBack-Fluid Management component improvement for Back up fuel cell systems* the control line for the final quality control of blowers for fuel-cell systems has been designed. It consists of two modules. The first module examines the bearing quality

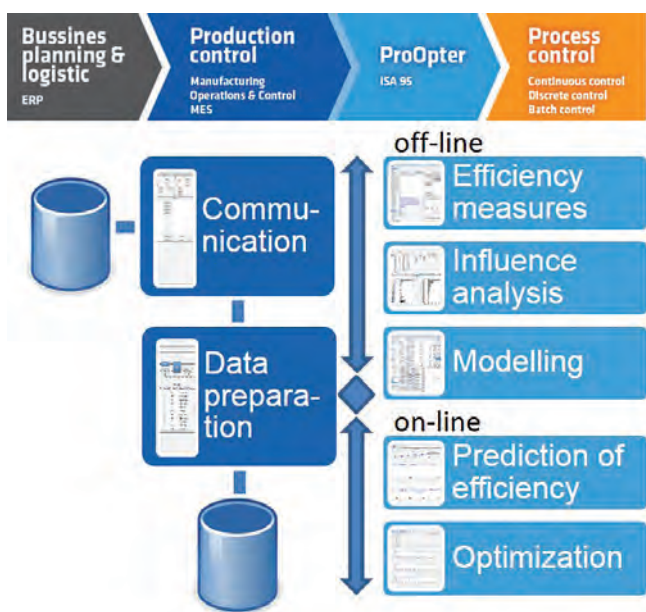


Figure 3: Placement scheme of a software tool ProOpter

by analysing the sound emissions. The second module examines the vibrational and electrical signals. The overall quality is estimated based on the calculated features.

R&D projects for industry and other users

A substantial part of the department's R&D activities for industry and other users is conducted within the project *Competence Centre for Advanced Control Technologies*, which has been concluded in 2013. Within the programme of the Competence Centre for Advanced Control Technologies our department members developed a number of innovative technological solutions in cooperation with industrial partners. The developed control tools and building blocks include advanced control algorithms that were implemented within the software tools of the Inea and Kolektor Sinabit companies for the easy implementation of advanced control in industrial processes. In addition, an industrial prototype of a tool for the model-driven development of the process control software was developed. In the field of a smart factory, a ProOpter production dynamics analyser and optimiser was developed and tested in batch production at our partner Helios, while the platform for on-line condition monitoring of industrial assets, implemented at the company Litoštroj Power, was integrated with the existing information system in the company. The control solutions for the efficient use of energy include the design of an algorithm for the optimal selection of heating and cooling systems in smart buildings that was implemented and tested by the company Goap, while the improved control of the anaerobic fermenter in the production of biogas was implemented by Kolektor Sinabit and tested on a pilot-scale batch reactor. A particular challenge in the field of energy production is the control of a fusion reactor. Within the realistic demonstrator of controlling plasma position, which was designed by the company Cosylab, an improved control solution based on a predictive controller was developed for plasma position control. Finally, within this programme our department members are planning to submit two patent applications and two innovations as leading partners.

Another important part of our activities is also devoted to direct cooperation with various companies.

In the project for Danfoss Trata d.o.o., the hardware and the firmware for "heavy-duty" motor drives have been developed (Figure 4). The drives are now in a trial production phase at Danfoss Trata, d.o.o. The drives have an anti-oscillation function that increases the expected lifespan of the drives and decreases the energy consumption. In addition to the heavy-duty drives, the concept of so-called "integration drives" has been developed and tested as well. Integration drives are used for tighter control of the output water temperature from heat exchangers.

An online estimation of the remaining useful life of electromotors is a challenging task. In the company Domel d.o.o. we developed and installed a line for the long-life testing of electronically commutated motors. The installed measuring equipment allows sufficiently accurate data acquisition and local data processing as well as an estimation of the remaining useful life. The final goal is the development of an embedded module for the estimation of the remaining useful life that will be an integral part of the final product.

In collaboration with the Centre of Excellence Low-carbon technologies, special DC/DC converters have been finalised and delivered to a number of national and European customers.

Publication of the book "Case Studies in Control - Putting Theory to Work"

The book entitled *"Case Studies in Control - Putting Theory to Work"* appeared in 2013 in the Springer series "Advances in Industrial Control". The book editors Prof. Dr. Stanko Strmčnik and Prof. Dr. Đani Juričić raised the topic of advanced control based on a number of case studies presented by our department members. The book summarizes the long-standing efforts and knowledge of our department in the field of the research of advanced control methods and their transfer to industrial practice. *Case Studies in Control* presents a framework to facilitate the use of advanced control concepts in real systems based on two decades of research and over 150 successful applications for industrial end-users from various backgrounds.

Educational and training activities

Some members of the department are giving lectures and practical courses at different faculties and universities: the Faculty of Electrical Engineering, University of Ljubljana, the Faculty of Logistics, University of Maribor, the University of Nova Gorica and the "Jožef Stefan" International Postgraduate School. They also act as supervisors of Ph.D. students.



Figure 4: "Heavy-duty" valve drive for Danfoss Trata d.o.o.

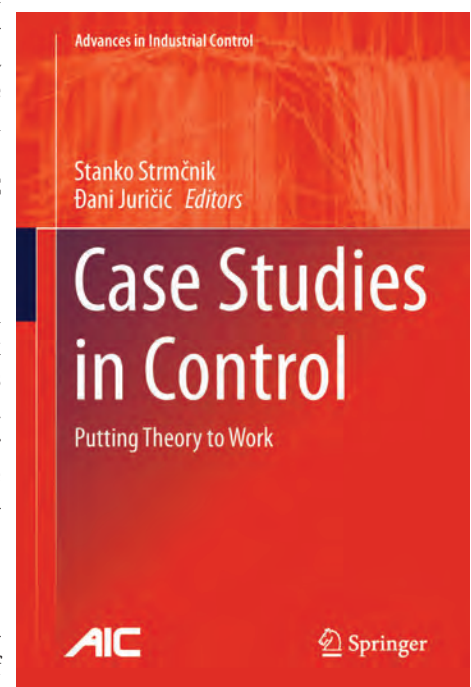


Figure 5. Cover of the book *Case Studies in Control - Putting Theory to Work*

Some outstanding publications in the past year

1. Kocijan, J., Hvala, N.: Sequencing batch-reactor control using Gaussian-process models. *Bioresource technology*, ISSN 0960-8524, vol. 137, 340–348
2. Hvala, N., Kukanja, D.: Modelling and simulation of semi-batch polymerisation reactor for improved reactants dosing control. *Simulation modelling practice and theory*, ISSN 1569-190X, vol. 33, no. 1, 102–114
3. Lukman, T., Godena, G., Gray, Jeffrey G., Heričko, M., Strmčnik, S.: Model-driven engineering of process control software beyond device-centric abstractions. *Control engineering practice*, ISSN 0967-0661, vol. 21, no. 8, 1078–1096
4. Petelin, D., Grancharova, A., Kocijan, J.: Evolving Gaussian process models for prediction of ozone concentration in the air. *Simulation modelling practice and theory*, ISSN 1569-190X, vol. 33, 68–80
5. Glavan, M., Gradišar, D., Atanasijević-Kunc, M., Strmčnik, S., Mušič, G.: Input variable selection for model-based production control and optimisation. *The international journal of advanced manufacturing technology*, ISSN 0268-3768, 2013, vol. 68, no. 9/12, 2743–2759
6. Glavan, M., Gradišar, D., Strmčnik, S., Mušič, G.: Production modelling for holistic production control. *Simulation modelling practice and theory*, ISSN 1569-190X, jan. 2013, vol. 30, 1–20

The most important achievements in the past year

1. The book “Case Studies in Control - Putting Theory to Work” edited by Prof. Dr. Stanko Strmčnik and Prof. Dr. Dani Juričić was published in the Springer series “Advances in Industrial Control”.
2. The article on modelling and control of polymerization process has been ranked among the most downloaded articles in Computers & Chemical Engineering Journal.
3. The first dedicated DC/DC converters for fuel-cell systems have been sold on the European market.
4. Successful completion of a multi-annual project “Competence Centre for Advanced Control Technologies” where the department E2 was involved in several development subprojects.
5. Successful completion of a multi-annual work within the “Centre of Excellence Low-carbon technologies” where we were in charge for the research on the field of hydrogen technologies.

Awards and appointments

1. Nadja Hvala: The article "Modelling, simulation and control of an industrial, semi-batch, emulsion-polymerization reactor" in Computers and Chemical Engineering Journal has according to Elsevier more than 500 downloads. It has been identified as one of the most downloaded articles in this journal in the period from Sept. 2012 - Aug. 2013 and has received a certificate for this contribution.

INTERNATIONAL PROJECTS

1. Production of DC/DC Converters
PowerCell Sweden AB
Dr. Janko Petrovčič
2. 7FP - FCGEN; Fuel Cell Based On-board Power Generation
European Commission
Dr. Boštjan Pregelj
3. 7FP - FLUMABACK; Fluid Management Component Improvement for Back up Fuel Cell Systems
European Commission
Dr. Pavle Boškosi
4. CERACON; Integration and Control of Liquid Fuel processor based on Ceramic Micro-Systems
ESA/ESTEC.
Dr. Gregor Dolanc
5. COST IC0806, IntelliCIS; Intelligent Monitoring, Control, and Security of Critical Infrastructure Systems
COST Office
Dr. Nadja Hvala

R&D GRANTS AND CONTRACTS

1. Prognostics and health management of mechanical drives based on novel MEMS sensor networks
Prof. Dani Juričić
2. Development and implementation of a method for on-line modelling and forecasting of air pollution
Prof. Juš Kocijan
3. Optimisation of energy cost for refrigeration systems in shopping malls
Asst. Prof. Damir Vrančič
4. On-line System Identification for Model-Based Prognostics and Health Management
Dr. Matej Gašperin
5. Competence Centre for Advanced Control Technologies: CC ACT
Asst. Prof. Damir Vrančič
6. Probasensor: EUROSTARS; Probabilistic Bayesian Soft Sensor - A Tool for On-line Estimation of the Key Process Variable in Cold Rolling Mills
Prof. Dani Juričić

NEW CONTRACTS

1. Process Control Software Development Methodology
Inea, d. o. o.
Giovanni Godena, M. Sc.
2. Prognostics and Health Management of Mechanical Drives Based on Novel MEMS Sensor Networks
Domel, d.o.o.
Prof. Dani Juričić

RESEARCH PROGRAM

1. Program Systems and Control
Prof. Dani Juričić

- Development and Implementation of a Method for On-line Modelling and Forecasting of Air Pollution
MEIS environmental services, d.o.o.
Prof. Juš Kocijan
- Optimisation of Energy Cost for Refrigeration Systems in Shopping Malls
Entia, d.o.o.
Asst. Prof. Damir Vrančić

VISITORS FROM ABROAD

- Prof. Diego Galar, Luleå University of Technology, Luleå, Sweden, 2.-6. 9. 2013
- Asst. prof. Václav Šmídl, University of West Bohemia, Plzen, Czech Republic, 2.-4. 10. 2013

STAFF

Researchers

- Dr. Gregor Dolanc
- Dr. Samo Gerškšič
- Giovanni Godena, M. Sc.
- Dr. Dejan Gradišar
- Dr. Nadja Hvala
- Dr. Vladimir Jovan, Head**
- Prof. Dani Juričić
- Prof. Juš Kocijan
- Dr. Bojan Musizza
- Dr. Janko Petrovčič
- Prof. Stanislav Strmčnik
- Asst. Prof. Damir Vrančić
- Dr. Darko Vrečko

Postdoctoral associates

- Dr. Pavle Boškoshi
- Dr. Matej Gašperin

- Dr. Marko Nerat
- Dr. Matija Perne
- Dr. Boštjan Pregelj

Postgraduates

- Andrej Debenjak, B. Sc.
- Boštjan Dolenc, B. Sc.
- Miha Glavan, B. Sc.
- Dejan Petelin, B. Sc.
- Martin Stepančić, B. Sc.
- Aleš Svetek, M. Sc.

Technical officers

- Stanislav Černe, B. Sc.
- Primož Fajdiga, B. Sc.

Technical and administrative staff

- Maja Janežič, B. Sc.
- Miroslav Štrubelj

BIBLIOGRAPHY

ORIGINAL ARTICLE

- Darko Aleksovski, Juš Kocijan, Sašo Džeroski, "Model tree ensembles for modeling dynamic systems", In: Discovery science: 16th International Conference, DS 2013, Singapore, October 6-9, 2013, proceedings, *Lect. Notes Comput. Sci.*, vol. 8140, pp. 17-32, 2013.
- Darko Belavič, Marko Hrovat, Gregor Dolanc, Kostja Makarovič, Marina Santo-Zarnik, "Design and fabrication of an LTCC structure for a microceramic combustor: invited paper", *J. microelectron. electron. packag.*, vol. 9, no. 3, pp. 120-125, 2013.
- Andrej Debenjak, Matej Gašperin, Boštjan Pregelj, Maja Atanasijević-Kunc, Janko Petrovčič, Vladimir Jovan, "Detection of flooding and drying inside a PEM fuel cell stack", *Stroj. vestn.*, vol. 59, no. 1, pp. 56-64, Jan. 2013.
- Andrej Debenjak, Bojan Musizza, Matej Gašperin, Janko Petrovčič, "Diagnostični modul za gorivne celice s protonsko prevodno membrano", *Ventil (Ljubl.)*, vol. 19, no. 3, pp. 200-206, jun. 2013.
- Samo Gerškšič, Gianmaria de Tommasi, "Vertical stabilization of ITER plasma using explicit model predictive control", In: Proceedings of the 27th Symposium On Fusion Technology, SOFT-27, Liège, Belgium, September 24-28, 2012, *Fusion Eng. Des.*, vol. 88, no. 6/8, pp. 1082-1086, 2013.
- Miha Glavan, Dejan Gradišar, Maja Atanasijević-Kunc, Stanko Strmčnik, Gašper Mušič, "Input variable selection for model-based production control and optimisation", *Int. j. adv. manuf. technol.*, vol. 68, no. 9/12, pp. 2743-2759, 2013.
- Miha Glavan, Dejan Gradišar, Stanko Strmčnik, Gašper Mušič, "Production modelling for holistic production control", *Simulation modelling practice and theory*, vol. 30, pp. 1-20, jan. 2013.
- Nadja Hvala, Dolores Kukanja, "Modelling and simulation of semi-batch polymerisation reactor for improved reactants dosing control", In: EUROSIM 2010 special issue, *Simul. Model. Pract. Theory*, vol. 33, no. 1, pp. 102-114, 2013.
- Ulf Jeppsson *et al.*, (17 avtorjev) "Benchmark simulation models, quo vadis?", *Water sci. technol.*, vol. 68, no.1, pp. 1-15, 2013.
- Juš Kocijan, Nadja Hvala, "Sequencing batch-reactor control using Gaussian-process models", *Bioresour. technol.*, vol. 137, pp. 340-348, jun. 2013.

- Tomaž Lukman, Giovanni Godena, Jeffrey G. Gray, Marjan Heričko, Stanko Strmčnik, "Model-driven engineering of process control software beyond device-centric abstractions", *Control eng. pract.*, vol. 21, no. 8, pp. 1078-1096, 2013.
- Dejan Petelin, Alexandra Grancharova, Juš Kocijan, "Evolving Gaussian process models for prediction of ozone concentration in the air", In: EUROSIM 2010 special issue, *Simul. Model. Pract. Theory*, vol. 33, pp. 68-80, apr. 2013.

REVIEW ARTICLE

- Ingrid Petrič, Dejan Gradišar, Miha Glavan, Stanko Strmčnik, "Ključni kazalniki za merjenje uspešnosti proizvodnje", *Uporab. inform. (Ljubl.)*, vol. 21, no. 2, pp. 95-106, apr./maj/jun. 2013.

SHORT ARTICLE

- Matej Gašperin, Klemen Žagar, Drago Bokal, Klemen Strniša, Gašper Pajor, L. Medeiros-Romao, D. Vandeplassche, "Predictive diagnostics for high-availability accelerators", *Control sheet*, vol. 16, no. 9, pp. 2'3, 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

- Juš Kocijan, "Incorporating knowledge about model structure in the identification of Gaussian-process models", In: *Recent advances in telecommunications, signals and systems: proceedings of the 12th International Conference on Data Networks, Communications, Computer (DNCOCO '13), proceedings of the 12th International Conference on Non-Linear Analysis, Non-Linear Systems and Chaos (NOLASC '13), proceedings of the 9th International Conference on Dynamical Systems and Control (CONTROL '13), proceedings of the 6th International Conference on Sensors and Signals (SENSIG '13), proceedings of the International Conference on Visualization, Imaging and Simulations (VIS '13), Marc 21-23, 2013, Lemesos, Cyprus*, (Recent advances in electrical engineering series, 10), Andreas Kanarachos, ed., [S. I.], WSEAS, 2013, pp. 124-129.

PUBLISHED CONFERENCE CONTRIBUTION

1. Pavle Boškosi, Đani Juričić, "Detection of bearing faults based on inverse Gaussian mixtures model", In: *Surveillance 7: international conference: October 29-30, 2013, Chartres, France*, Chartres, Institute of Technology, 2013, 12 pp.
2. Pavle Boškosi, Đani Juričić, "MIMOSA OSA-EAI standard za E-Vzdrževanje", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 7 pp.
3. Pavle Boškosi, Đani Juričić, "Modeling localized bearing faults using inverse Gaussian mixtures", In: *PHM'13, Annual Conference on Prognostics and Health Management Society, 14 October - 17 October 2013, New Orleans, USA, Denver, IEEE*, 2013, 7 pp.
4. Henry Rafael Concepcion, Darko Vrečko, Montse Meneses, Ramon Vilanova, "Control strategies for removing nitrogen compounds in waste water treatment plants", In: *ASCC 2013, 2013 9th Asian Control Conference, June 23-26, 2013, Istanbul, Turkey, Piscataway, IEEE*, cop. 2013, 6 pp.
5. Henry Rafael Concepcion, Darko Vrečko, Montse Meneses, Ramon Vilanova, "Evaluating the environmental performance of wastewater treatment plants control strategies", In: *Book of abstracts, 11th IWA Conference on Instrumentation Control and Automation, ICA 2013, 18-20 September 2013, Narbonne, France, [S. l.], IWA*, 2013, 4 pp.
6. Andrej Debenjak, Matej Gašperin, Janko Petrovčič, "On-line tracking of fuel cell system impedance using extended Kalman filter", In: *Proceedings of the PHM2013, 2013 Prognostic and System Health Management, 8-11 September 2013, Milano, Italy*, (Chemical engineering transactions, vol. 33, 2013), Milano, AIDIC, 2013, vol. 33, pp. 1003-1008, 2013.
7. Andrej Debenjak, Bojan Musizza, Matej Gašperin, Janko Petrovčič, "Modul za sprotno diagno stiko PEM gorivnih celic", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 7 pp.
8. Gregor Dolanc, Marko Hrovat, Primož Fajdiga, Stanko Hočevar, Andrej Pohar, Kostja Makarovič, Darko Belavič, "System with ceramic LTCC micro-reactor for steam reforming", In: *Proceedings, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2013*, pp. 251-256.
9. Jaka Fritz, Boštjan Pregelj, Janko Petrovčič, Maja Atanasijević-Kunc, "Modeliranje sistema s PEM gorivnimi celicami", In: *Zbornik dvaindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2013, 16.-18. september 2013, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2013, zv. A, pp. 185-188.
10. Franci Gabrovšek, Matija Perne, "Evolution of conduit network in transition from pressurised to free surface flow", In: *Proceedings, 16th International Congress of Speleology, Brno, Czech Republic, July 21-28, 2013, Michal Filippi, ed., Pavel Bosák, ed., Brno, International Union of Speleology, Czech Speleological Society, 2013*, vol. 2, pp. 347-348.
11. Matej Gašperin, Pavle Boškosi, "Signal processing and stochastic filtering for EIS based PHM of fuel cell systems", In: *FDPC 2013, 5th International Conference on Fundamentals & Development of Fuel Cells, 16-18th April, 2013, Karlsruhe, Germany, [S. l., s. n.]*, 2013, 8 pp.
12. Samo Gerkišič, Boštjan Pregelj, Stanko Strmčnik, Aleš Šink, Tadej Jerovšek, Aleksander Pregelj, Igor Steiner, "Aplikativna izvedba poenostavljenega eksplicitnega prediktivnega regulatorja na pilotni napravi", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 7 pp.
13. Samo Gerkišič, Gianmaria de Tommasi, Klemen Žagar, "Regulacija vertikalnega položaja plazme v fuzijskem tokamaku reaktorju Iter", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 5 pp.
14. Miha Glavan, Dejan Gradišar, Gašper Mušič, "Podatkovni model za celostno vodenje proizvodne", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 8 pp.
15. Miha Glavan, Dejan Gradišar, Stanko Strmčnik, Gašper Mušič, "Orodje za analizo proizvodne dinamike", In: *Vir znanja in izkušenj za stroko: zbornik foruma, 5. industrijski forum IRT, Portorož, 10.-12. junij 2013*, Tomaž Perme, ed., Darko Svetak, ed., Škofljica, Profidtp, 2013, pp. 107-112.
16. Luka Goljevčček, Juš Kocijan, "Comparison between Gaussian process regression and support vector machines regression", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 47-50.
17. Dejan Gradišar, Miha Glavan, Gašper Mušič, "Metrike za merjenje učinkovitosti proizvodnje", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 8 pp.
18. Dejan Gradišar, Gašper Mušič, "Petri-net modelling for batch production", In: *Preprints, IFAC Conference on Manufacturing Modelling, Managements and Control, June 19-21, 2013, Saint Petersburg, Russia, [S. l.], IFAC*, 2013, pp. 1582-1587.
19. Boštjan Grašič, Primož Mlakar, Marija Božnar, Juš Kocijan, Gianni Tinarelli, "High quality air pollution dispersion modelling using high computational performance Lagrangian particle model", In: *Proceedings of the 15th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Madrid, Spain, 6-9 May 2013*, Roberto San José, ed., Juan Luis Pérez, ed., Madrid, Environmental Software and Modelling Group, Computer Science School, 2013, pp. 337-342.
20. Nadja Hvala, Zoran Marinšek, Tina Baggia, Stanko Strmčnik, Vladimir Jovan, "Raziskovalna področja in izzivi Kompetenčnega centra za sodobne tehnologije vodenja", In: *Zbornik dvaindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2013, 16.-18. september 2013, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2013, zv. A, pp. 123-126.
21. Janez Jamšek, Đani Juričić, Pavle Boškosi, "Lubrication starved bearings detection in electrical motors vibration signals by means of wavelet bispectral analysis", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 6 pp.
22. Janez Jamšek, Đani Juričić, Pavle Boškosi, Jože Vižintin, "Electrical motor fault detection from raw vibration signals by wavelet bispectral analysis", In: *Zbornik dvaindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2013, 16.-18. september 2013, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2013, zv. A, pp. 111-114.
23. Roland Jurcan, Peter Kavčič, Giovanni Gođena, "Optimizacija stroškov izvedbe sistemov vodenja šaržnih procesov z orodjem za delno avtomatsko generiranje programske kode", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 4 pp.
24. Đani Juričić, Pavle Boškosi, Janko Petrovčič, Bojan Musizza, "Implementation of diagnostics, prognostics and e-maintenance support under variable operating conditions", In: *Surveillance 7: international conference: October 29-30, 2013, Chartres, France*, Chartres, Institute of Technology, 2013, 16 pp.
25. Đani Juričić, Pavle Boškosi, Janko Petrovčič, Bojan Musizza, "A platform for diagnostics, prognostics and e-maintenance support", In: *SysTOL 2013, 2nd International Conference on Control and Fault-Tolerant Systems, October 9-11, 2013, Nice, France, [S. l., s. n.]*, 2013, pp. 820-825.
26. Matija Perne, "Dinamični 1D model vode v membrani in elektrodah gorivne celice s protonsko prevodno membrano", In: *Zbornik osme konference AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 4 pp.
27. Dejan Petelin, Pavle Boškosi, Matej Gašperin, Đani Juričić, "Diagnostika in prognostika stanja industrijske opreme", In: *Vir znanja in izkušenj za stroko: zbornik foruma, 5. industrijski forum IRT, Portorož, 10.-12. junij 2013*, Tomaž Perme, ed., Darko Svetak, ed., Škofljica, Profidtp, 2013, pp. 127-132.
28. Boštjan Pregelj, Jaka Fritz, Darko Vrečko, Vladimir Jovan, "Model agregata z gorivnimi celicami HyPM HD 8-200", In: *Zbornik osme*

- konferenca AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 7 pp..
29. Boštjan Pregelj, Jaka Fritz, Darko Vrečko, Janko Petrovčič, Vladimir Jovan, Andrej Debenjak, "Model of an 8-kW fuel cell based power unit for operation monitoring, optimization and control testing", In: *Eurosim 2013*, 8th EUROSIM Congress on Modelling and Simulation, 10-13 September 2013, Cardiff, Wales, Khalid Al-Begain, ed., [et al.], IEEE = Institute of Electrical and Electronics Engineers, 2013, 6 pp.
 30. Aleksander Pregelj, Igor Steiner, Damir Vrančič, Igor Škrjanc, "Primerjava realnega PI in PFC vodenja avtoklava", In: *Zbornik osme konferenca AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 6 pp..
 31. Václav Šmídl, Matej Gašperin, "Rao-blackwellized point mass filter for reliable state estimation, er", In: *FUSION 2013*, [S. l.], ISIF = International Society of Information Fusion, 2013, 7 pp.
 32. Jože Vižintin, Gabrijel Peršin, Boris Kržan, Đani Juričič, Borut Kalmer, "Vzdrževanje po stanju: od principov do komercialnih rešitev", In: *Zbornik osme konferenca AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 12 pp..
 33. Jože Vižintin, Gabrijel Peršin, Boris Kržan, Đani Juričič, Borut Kalmer, "Vzdrževanje po stanju: od principov do komercialnih rešitev", In: *Zbornik osme konferenca AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, pp. [1.12].
 34. Damir Vrančič, Janko Petrovčič, Zoran Šaponja, Samo Krančan, Saša Kojić, "Nadgradnja inteligentnega motornega pogona", In: *Zbornik osme konferenca AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 8 pp..
 35. Darko Vrečko, Rok Babič, Uroš Zupančič, "Izboljšanje regulacije prezračevanja prezračevalnikov na CCN Ljubljana", In: *Zbornik referatov: [simpozij z mednarodno udeležbo]*, Vodni dnevi 2013, Portorož, 16.-17. oktober 2013, Milenko Roš, ed., Ljubljana, Slovensko društvo za zaščito voda, 2013, pp. 38-47.
 36. Darko Vrečko, Satja Lumbar, Narcis Vodopivec, "Algoritem za optimalno izbiro sistemov gretja in hlajenja v prostorih stavb", In: *Zbornik osme konferenca AIG'13 Avtomatizacija v industriji in gospodarstvu, 4. in 5. april 2013, Maribor, Slovenija*, Boris Tovornik, ed., Nenad Muškinja, ed., Milan Rotovnik, ed., Maribor, Društvo avtomatikov Slovenije, 2013, 7 pp..
 37. Darko Vrečko, Uroš Zupančič, Rok Babič, "Improvement of aeration control in Ljubljana WWTP", In: *Book of abstracts*, 11th IWA Conference on Instrumentation Control and Automation, ICA 2013, 18-20 September 2013, Narbonne, France, [S. l.], IWA, 2013, 4 pp.
 38. Klemen Žagar, Drago Bokal, Klemen Strniša, Matej Gašperin, Gašper Pajor, L. Medeiros-Romao, D. Vandeplassche, "Predictive diagnostics for high-availability accelerators", In: *Proceedings of 4th International Particle Accelerator Conference, IPAC 2013, May 13-17, 2013, Shanghai, China*, [S. l.], JACoW, 2013, pp. 873-875.
 3. Samo Gerškšč, Gregor Dolanc, Damir Vrančič, Juš Kocijan, Stanko Strmčnik, Sašo Blažič, Igor Škrjanc, Zoran Marinšek, Miha Božiček, Anna Stathaki, Robert Bruce King, Mincho B. Hadjiski, Kosta Boshnakov, "A PLC-based system for advanced control", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 327-361.
 4. Samo Gerškšč, Boštjan Pregelj, "Tracking explicit model predictive controllers for low-level control applications", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 77-100.
 5. Giovanni Godena, Tomaž Lukman, Gregor Kandare, "A new approach to control systems software development", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 363-406.
 6. Đani Juričič, Matej Gašperin, Bojan Musizza, Gregor Dolanc, Igor B. Mekjavić, "A system for model-based quality assessment of burn-protective garments", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 257-285.
 7. Đani Juričič, Janko Petrovčič, Uroš Benko, Bojan Musizza, Gregor Dolanc, Pavle Boškoski, Dejan Petelin, "End-quality control in the manufacturing of electrical motors", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 221-256.
 8. Juš Kocijan, "The divide-and-Conquer method for modelling and control of nonlinear systems: some important issues concerning its application", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 101-126.
 9. Dejan Petelin, Juš Kocijan, "Streaming-data selection for Gaussian-process modeling", In: *Towards advanced data analysis by combining soft computing and statistics*, (Studies in fuzziness and soft computing, vol. 285), Christian Borgelt, Heidelberg [etc.], Springer, cop. 2013, pp. 177-190.
 10. Janko Petrovčič, Damir Vrančič, "Temperature control in a plastic extruder control system", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 157-183.
 11. Stanko Strmčnik, Đani Juričič, Janko Petrovčič, Vladimir Jovan, "Theory versus practice", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 1-33.
 12. Damir Vrančič, "Rapid prototyping environment for control systems implementation", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 289-326.
 13. Darko Vrečko, Nadja Hvala, "Model-based control of the ammonia nitrogen removal process in a wastewater treatment plant", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 127-153.

PATENT APPLICATION

1. Jože Vižintin, Jose Miguel Marques Querido Salgueiro, Boris Kržan, Gabrijel Peršin, Đani Juričič, Pavle Boškoski, Gregor Dolanc, *Apparatus and method for on-line monitoring of oil condition and debris concentration*, P-201300409, Urad RS za intelektualno lastnino, 3.12.2013.
2. Damir Vrančič, Marko Nerat, Samo Krančan, *Procedure of rapid signal filtering of rotational speed with automatic elimination of periodic deviation*, P-201300435, Urad RS za intelektualno lastnino, 19.12.2013.

MENTORING

1. Gabrijel Peršin, *Fault detection and localization of mechanical drives based on data fusion techniques*: doctoral dissertation, Ljubljana, 2013 (mentor Jožef Vižintin; co-mentor Đani Juričič).

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Gregor Dolanc, "Tension control in a steel slitting line", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 185-220.
2. Gregor Dolanc, Stanko Strmčnik, "Identification and control of nonlinear systems using a piecewise-linear Hammerstein model", In: *Case studies in control: putting theory to work*, (Advances in industrial control), Stanko Strmčnik, ed., Đani Juričič, ed., London [etc.], Springer, 2013, pp. 37-75.

ARTIFICIAL INTELLIGENCE LABORATORY

E-3

The Artificial Intelligence Laboratory (<http://ailab.ijs.si/>) is concerned mainly with the research and development of information technologies, with an emphasis on artificial intelligence. The main research areas are the following: data analysis with an emphasis on text, web and cross-modal data, scalable real-time data analysis, machine learning, analysis and modelling of large networks, visualization of complex data, semantic technologies, language technologies, reasoning methods and knowledge management. The Artificial Intelligence Laboratory has employees and students with an international background and with expertise in different areas of artificial intelligence. In addition to having their research results published in international publications, they have also developed several software tools for multimodal data analyses. Some of these tools are: Text-Garden, a suite of text mining tools; OntoGen (<http://ontogen.ijs.si/>), a tool for ontology learning; Document-Atlas (<http://docatlas.ijs.si/>), a tool for complex visualization; Atlas of Slovenian Science (<http://scienceatlas.ijs.si/>), a web portal for analyzing the scientific community; Enrycher (<http://enrycher.ijs.si/>), a system for semantic enrichment of textual data; SearchPoint (<http://searchpoint.ijs.si/>), a portal for visual and contextualized Web browsing; OntoPlus, a methodology for semi-automatic ontology extension; Contextify (<http://contextify.net/>), a tool for contextualized e-mail and contact management; NewsFeed (<http://newsfeed.ijs.si/>), a clean, continuous, real-time aggregated stream of semantically enriched news articles from RSS-enabled sites across the world; iDiversiNews (<http://aidemo.ijs.si/diversinews/>) a system for processing and visualizing news; Event registry (<http://eventregistry.org/>) a system for identifying mentioned world events in the news. The laboratory's strategy is to combine scientific excellence and strong industrial collaboration and to transfer research results into real-world business environments.



Head:
Prof. Dunja Mladenic

In the last 10 years, members of the Artificial Intelligence Laboratory successfully completed 32 EU projects, of which 5 were concluded in 2013. In addition, we were involved in another 12 EU FP7 projects in 2013, including 3 Networks of Excellence covering three complementary research areas: statistical data modelling and machine learning, language technologies and semantic technologies. Among our activities on national projects, we should emphasize our involvement in three national application projects and the successful conclusion of two competence centers.

In the area of statistical data modelling and machine learning, we have contributed Big Data Tutorial at three international conferences: ISWC, WWW, ICDM (Marko Grobelnik, Blaž Fortuna, Dunja Mladenic), Topological Data Analysis Tutorial at the international conference ICML-2013 (Primož Škraba) and an invited course on Big Data Analytics at the Brazilian Machine Learning and Knowledge Discovery in Databases School (Marko Grobelnik). In the EU FP7 project *XLike (Cross-lingual Knowledge Extraction)* coordinated by our department, we have developed technology for the real-time cross-lingual linking of news articles across languages. This allows us to identify news stories in one language and observe when and how these stories spread across language barriers. Cross-lingual linking was successfully tested on the Bloomberg.com website, where it provided additional local context to readers (i.e., German or Italian) while reading Bloomberg news articles in English. In the EU FP7 project *TOPOSYS (Topological Complex Systems)* coordinated by our department, we have made significant progress in understanding the underlying mathematical foundations of multi-scale dynamic systems, in particular using topological tools. Some examples include understanding behaviors such as periodicity or more generally, recurrence in high-dimensional configuration spaces as well as more abstract space such as feature spaces; understanding the statistics of invariants/features as a method to formalize the notion of noise in an experimental setting and finally, transitioning from local to global information in a multiscale

Dunja Mladenic had an invited talk “Information, Knowledge... Truth?” at an Out of The Box seminar.



Figure 1: Science Atlas portal for visualization of Slovenian research community based on publications and projects (showing a collaboration graph for a selected researcher from computer science).

Primož Škraba had an invited talk “A Topological Model of Recurrence” at the Israeli Statistics Association Annual Meeting 2013.

manner. In the EU FP7 project *Symphony (Orchestrating Information Technologies and Global Systems Science for Policy Design and Regulation of a Resilient and Sustainable Global Economy)* our work is mainly focused on developing tools and approaches for nowcasting. We have been working on establishing social media monitoring data infrastructure, tracking cross-lingual information and opinion diffusion, definition and development of social-media-based expectations indicators.

In the areas of **text and network analysis** and **language technologies**, we have organized “Knowledge Extraction from Text” Workshop at the international conference NIPS-2013. We have successfully concluded the EU FP7 Network of Excellence on Linguistics *METANet (Net Technologies for the Multilingual European Information Society)*, providing a detailed expert analysis and assessment of the current situation of language resources and technologies for Slovenian (<http://www.meta-net.eu/whitepapers/volumes/slovene>) and a Strategic Research Agenda for Multilingual Europe 2020 (<http://www.meta-net.eu/sra>). The results also include a network of repositories (<http://www.meta-share.org/>) of language data, tools and related web services documented with high-quality metadata, aggregated in central inventories, allowing for uniform search and access to resources now includes Slovenian language resources and applications. The European Social Fund project *Communication in Slovenian* was completed and resulted in a number of important Slovenian language resources, language technology applications and web portals. Text corpora include a 1.2-billion-word corpus of written texts Gigafida, a 100-million-word balanced corpus Kres, a 1-million-word spoken corpus Gos and a corpus of transcribed school essays Šolar (<http://eng.slovenscina.eu>). These databases can be explored online by using newly developed web concordancers. Lexical data includes a lexical database with semantic, syntactic, collocation and other data, and the Slovenian lexicon Sloleks where inflectional paradigms for more than 100,000 Slovenian words can be found. Some basic language technology applications were developed that were needed for the computer processing of text in the Slovenian language, such as Slovenian tagger and parser. We have also concluded the EU FP7 project *LT-Web*, where we are participating in the standardization process of natural language processing service providers. We have successfully concluded the *Slovenian Science Atlas*, a national project, publicly launching the available portal for searching and visualizing research collaboration and competences of Slovenian researchers. We have concluded the EU FP7 project *RENDER (Reflecting Knowledge Diversity)* where we have developed an iPad application iDiversiNews enabling the visualization of a live stream of news articles including an automatic summarization and opinion-mining application. In our new EU FP7 project *Sophocles (Self-Organised information Processing, Criticality and Emergence in multilevel Systems)*, we have been working on processing social media data (Twitter, news) with the goal of validating the theoretical models developed in the project. The main phenomena of interest are the emergence of scales in the data as well as the detection of critical events that drastically change the dynamics of the system.

In the area of **semantic technologies**, we contributed the Internet of Things Tutorial at the international conference ISWC-2013 (Marko Grobelnik and Carolina Fortuna) and a keynote talk ESWC Summer School on Semantic technologies 2013 (Marko Grobelnik). We have continued work on methods for measuring concept similarity in ontologies, where the experimental evaluation was performed on DBpedia, OpenCyc ontology and on the WordNet lexical database. Within *Planet Data (Intelligent Information Management)*, a EU Network of Excellence, we have collected a large body sensor of data from publicly available services in London and Madrid that have been processed as streams using the MS StreamInsight and Esper tools with the purpose of detecting events as described in the ‘Smart City’ use case in PlanetData. In collaboration with the Institute’s Communication Systems Department (E6), we have additionally investigated techniques for cleaning and repairing sensor data. The second line of work was concerned with text streams, for which best practices and lessons learnt regarding the development of a real-time infrastructure have been developed. We also focused on using the News Storyline Ontology for annotating text streams for the ‘New Registry’ use case. In our new EU FP7 project *ProaSense (The Proactive Sensing Enterprise)* we are developing tools and approaches for forecasting future undesired events in the production process to enable a reaction to them beforehand. The project is one of the early adopters of a shift from reactive to proactive computing. Our new FP7 EU project *XLime (Cross-Lingua, cross-Media knowledge extraction)* is dedicated to fusing the knowledge from different dimensions of media content providing a near-real-time continuously updated and comprehensive view on knowledge diffusion across media. We are developing methods for the analysis of information derived

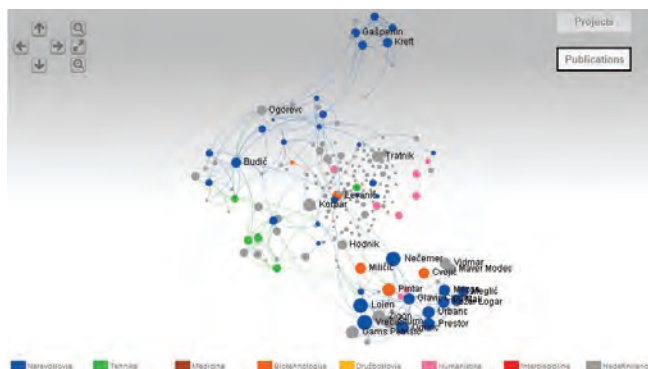


Figure 2: Science Atlas portal showing a collaboration graph in chemistry (based on research publications).

Marko Grobelnik had an invited talk “Introduction to Big Data” at the European Data Forum 2013.

have been processed as streams using the MS StreamInsight and Esper tools with the purpose of detecting events as described in the ‘Smart City’ use case in PlanetData. In collaboration with the Institute’s Communication Systems Department (E6), we have additionally investigated techniques for cleaning and repairing sensor data. The second line of work was concerned with text

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from various media channels, such as audio, video, text and social media as a first step towards the development of a real-time comprehensive view on knowledge diffusion across media and languages.

Knowledge management includes research and development by using methods and tools from a broader Artificial Intelligence area in real business settings. Following the invitation, we have organized a workshop for European anti-corruption agencies “EPAC/EACN Technical Seminar”. The aim of the FP7 EU project *NRG4Cast (Energy Forecasting)* coordinated by our department, is the development of real-time management, analytics and forecasting services for energy distribution networks in urban/rural communities. Our work is focused on analyzing multimodal data streams from the energy domain. During the first year of the project, we have obtained and integrated sensor data streams and global services into an analytical platform, where analytical methods for data cleaning and fusion were applied. The first integrated prototype was released and validated by NRG4Cast case study partners: IREN, CSI and Envigence. In the FP7 EU project *MobiS (Personalized Mobility Services for energy efficiency and security through advanced Artificial Intelligence techniques)* we have developed services for traffic data collection, cleaning and fusion, used by the traffic-prediction services, which are also being developed. Part of this is a novel approach to the incremental decision-tree learning on data streams. We have also extended the Cyc ontology to be used within the traffic domain and exploited the Cyc reasoner to behave as an expert system, helping operators in the traffic call center (AMZS). We developed a novel knowledge-capture service, which is being used to populate the traffic knowledge base extension mentioned before. All these services together serve as a traffic platform, which is currently used by the call-center expert system and custom mobile application prototype (Mobis Commuting Assistant) with the idea to help the daily commuters on their travels. In the FP EU project *Mediamixer (Community set-up and networking for the remixing of online media fragments)* we have been working on the use of fragmented media content.

Promotion of science is continually present in the efforts of the Artificial Intelligence Laboratory. We have been organizing a touring exhibition about female PhD holders from the area of computer science in Slovenia since 2006, thereby promoting the role of women in science (<http://ScienceWithArt.ijs.si/>). Our activities on *TransLectures (Transcription and Translation of Video Lectures)*, a EU FP7 project, where we collaborate with the Centre for Knowledge Transfer in Information Technologies (CT3) on the automated subtitling and translating of video recordings, were focused on developing innovative tools for the automatic transcription and translation of educational video material. Together with CT3, we continued to use the videolectures.NET portal to promote artificial intelligence, the Jožef Stefan Institute and Slovenian research in general. Our laboratory is also the main organizer and supporter of the annual national ACM Computer Science Competition for secondary-school students; this year, more than 200 students participated in the competition. Following the invitation, we have organized a workshop at OCWC Global 2013 “Advanced Methods and Tools for Web-Based Education”.

In 2013, we were very actively involved in submitting new project proposals, particularly within the 7th Framework Programme. Once again, we were very successful in this, obtaining funding for three new projects: Proasense, Symphony and XLime. We continued with our successful efforts to include the Slovenian industry into the European research area; the list of 16 companies participating in EU projects has been extended by two.

Some outstanding publications in the past year

1. Novalija, I., Mladenici, D.: Applying semantic technology to business news analysis. *Applied artificial intelligence*, 2013, 27:6, 520–550
2. Chazal, F., Guibas, Leonidas J., Oudot, S., Škraba, P.: Persistence-based clustering in riemannian manifolds. *Journal of the ACM*, December 2013
3. Tomašev, N., Mladenici, D.: Class imbalance and the curse of minority hubs. *Knowledge-based systems*, 2013

Together with the Centre for Knowledge Transfer in Information Technologies, we received the World Summit Award (WSA) for Videolectures.net. Among 200 WSA winners from the last decade, 8 all-time bests were selected; VideoLectures.Net was selected as the winner in the “e- Science & Technology” category.

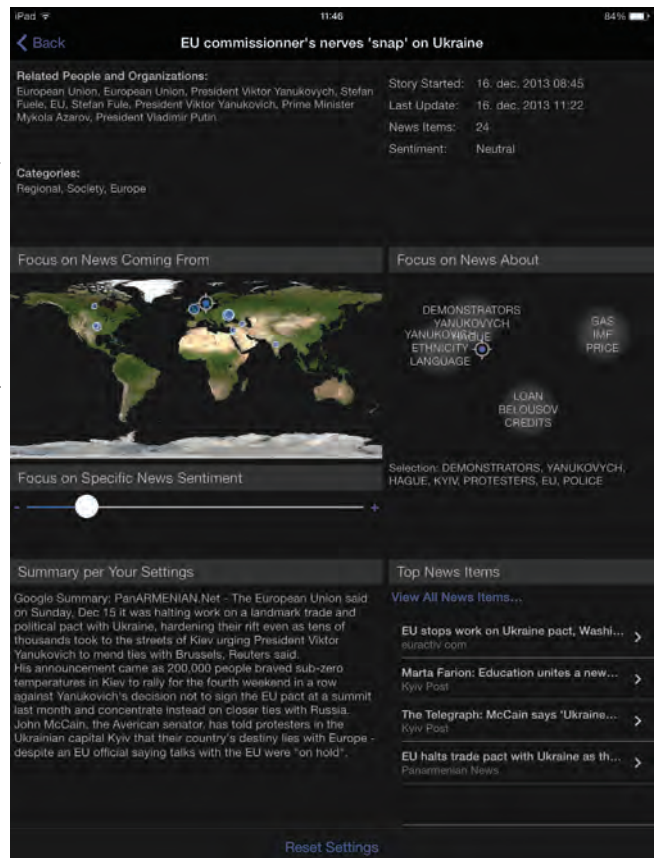


Figure 3: iDiversiNews iPad application visualizing live stream of news articles filtered by topic, sentiment and geographical location.

4. Anderson, A., Huttenlocher, Daniel P., Kleinberg, J., Leskovec, J.: Steering user behavior with badges. In 22nd World Wide Web Conference, *WWW-2013*, May 2013, 95–106
5. Kenda, K., Fortuna, C., Moraru, A., Mladenici, D., Fortuna, B., Grobelnik, M.: Mashups for the web of things. In: ENDRES-NIGGEMEYER, Brigitte (ed.). *Semantic mashups: intelligent reuse of web resources*, 2013, 45–169, Berlin; Heidelberg: Springer

Organization of conferences, congresses and meetings

1. First International Ljubljana-Zagreb Workshop on Artificial Intelligence, Jeruzalem, Slovenia, 3.–5. 6. 2013
2. Conference on Data Mining and Data Warehouses, Ljubljana, Slovenia, 8. 10. 2013

INTERNATIONAL PROJECTS

1. 7FP - PASCAL2; Pattern Analysis, Statistical Modelling and Computational Learning 2
European Commission
Prof. Dunja Mladenici
2. 7FP - MetaNET; Technologies for the Multilingual European Information Society
European Commission
Marko Grobelnik
3. 7FP - RENDER; Reflecting Knowledge Diversity
European Commission
Prof. Dunja Mladenici
4. 7FP - PlanetData
European Commission
Marko Grobelnik
5. 7FP - ALERT; Active Support and Real-time Coordination based on Event Processing in
Open Source Software Development
European Commission
Prof. Dunja Mladenici
6. 7FP - SiS CATALYST; Children as Change Agents for the Future of Science in Society
European Commission
Prof. Dunja Mladenici
7. 7FP - transLectures; Transcription and Translation of Video Lectures
European Commission
Prof. Dunja Mladenici
8. 7FP - LT-Web; Language Technology in the Web
European Commission
Prof. Dunja Mladenici
9. 7FP - Sophocles; Self-Organised information Processing, Criticality and Emergence in
multilevel Systems
European Commission
Marko Grobelnik
10. 7FP - MEDIAMIXER; Community Set-up and Networking for the Remixing of Online
Media Fragments
European Commission
Marko Grobelnik
11. 7FP - MobIS: Personalized Mobility Services for Energy Efficiency and Security through
Advanced Artificial Intelligence Techniques
European Commission
Marko Grobelnik
12. 7FP - ProaSense; The Proactive Sensing Enterprise
European Commission
Marko Grobelnik
13. 7FP - SYMPHONY; Orchestrating Information Technologies and Global Systems Science
for Policy Design and Regulation of a Resilient and Sustainable Global Economy
European Commission
Prof. Dunja Mladenici
14. 7FP - xLiMe; CrossLingual CrossMedia Knowledge Extraction
European Commission
Marko Grobelnik
15. 7FP - X-Like; Cross-lingual Knowledge Extraction
European Commission
Marko Grobelnik
16. 7FP - TOPOSYS; Topological Complex System
European Commission
Dr. Primož Škraba

17. 7FP - NRG4CAST; Energy Forecasting
European Commission
Maja Škrjanc, B. Sc.
18. PARSEME: PARsing and Multi-Word Expressions. Towards Linguistic Precision and
Computational Efficiency in Natural Language Processing.
COST Office
Dr. Simon Krek
19. IS1305, European Network of E-Lexicography (ENEL)
COST Office
Dr. Simon Krek

RESEARCH PROGRAM

1. Knowledge Technologies
Prof. Dunja Mladenici

R&D GRANTS AND CONTRACTS

1. Information-Communication Technologies and Transformation of Survey Research in
Social Sciences
Marko Grobelnik
2. Model for Domain-Specific Trend Prediction based on Semantic Enrichment of
Unstructured Patterns
Prof. Dunja Mladenici
3. Quality of Service and Quality of Experience Measurement and Control System in
Multimedia Communications Environments
Marko Grobelnik
4. Co-authorship Networks of Slovenian Scholars: Theoretical Analysis and Visualization
User Interface Development
Prof. Dunja Mladenici
5. Slovene Research Atlas
Prof. Dunja Mladenici
6. Open Communication Platform for Service Integration: CC OPCOMM
Prof. Dunja Mladenici
7. Cloud Assisted Services: CC CLASS
Marko Grobelnik
8. Communication in Slovenian Language
Dr. Simon Krek

NEW CONTRACTS

1. Development Project for Establishing a Platform of Advanced Services for Energy
Management of Household Consumers
Solvera Lynx, d. d.
Marko Grobelnik
2. Technologies for Next-generation Intelligent Motorhome
Adria Mobil, d. o. o., Novo mesto
Marko Grobelnik

VISITORS FROM ABROAD

1. Ramesh Viswanathan, Siemens, Bengaluru, India, 3.–5. 1. 2013
2. Boštjan Špetič, Zemanta, New York, USA, 16. 1. 2013
3. Yannis Charalabidis, University of Aegean, Athens, Greece, 22. 1. 2013
4. Rachel Jones, Instrata Ltd., London, UK, 3.–6. 2. 2013
5. Rudi Studer, Maria Maleshkova, Fabian Floeck, KIT, Karlsruhe, Germany, 3.–6. 2. 2013
6. Abhijit Bhole, Microsoft research India, New Delhi, India, 13. 2. 2013
7. Maks Ovsjanikov, Ecole Polytechnique, Paris, France, 25. 2.–3. 3. 2013
8. Michael Witbrock, Cypcorp Europe d.o.o., Ljubljana, Slovenia, 24.–27. 2. 2013, 19.–23. 6. 2013
9. Abraham Hsuan, Irwin & Hsuan LLC, New York, USA, 25.–30. 3. 2013, 2.–9. 10. 2013
10. Mark Jarecke, Elizabeth Stafford, Mike Lee, FOUR32C, New York, USA, 23.–30. 3. 2013
11. Marko Tadić, University of Zagreb, Zagreb, Croatia, 25.–26. 3. 2013
12. Kiyoshi Nitta, Yahoo! Research, Tokio, Japan, 29. 4. 2013
13. Božidar Kliček, Faculty of Organization and Informatics, Varaždin, Croatia, 10. 6. 2013

14. Dijana Oreški, Faculty of Organization and Informatics, Varaždin, Croatia, 11. 6. 2013
15. Alek Kolcz, Twitter, San Francisco, USA, 20.-23. 6. 2013
16. Danica Kragić, KTH, Stockholm, Sweden, 1.-4. 6. 2013
17. Ulrich Bauer, Hubert Wagner, IST Austria, Klosterneuburg, Austria, 1.-4. 7. 2013
18. Mateusz Juda, Jagiellonian University, Krakow, Poland, 1.-4. 7. 2013
19. Florian Pokorny, KTH, Stockholm, Sweden, 1.-4. 7. 2013
20. Calin Railean, Technical University Cluj-Napoca, Cluj-Napoca, Romania, 1.-15. 9. 2013
21. Frank van Harmelen, VU Amsterdam, Amsterdam, Netherlands, 27. 6.-7. 7. 2013
22. Lynd Hratman, CWI Amsterdam, Amsterdam, Netherlands, 28. 6.-7. 7. 2013
23. Rok Sosič, Stanford University, Palo Alto, USA, 23. 8. 2013
24. Christopher Stone, Harvey Mudd College, Claremont, USA, 19. 9. 2013
25. Olegas Niksou, Vilnius University, Vilnius, Lithuania, 7.-8. 10. 2013
26. Konstantinos Kalaboukas, SingularLogic, Athens, Greece, 14. 10. 2013
27. Colin de la Higuera, Université de Nantes - LINA, Nantes, France, 8.-13. 11. 2013
28. Mirjana Ivanović, Miloš Radovanović, University of Novi Sad, Novi Sad, Serbia, 17.-19. 11. 2013

STAFF

Researchers

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32. Matjaž Rihtar, B. Sc.
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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Bojan Blažica, Daniel Vladušič, Dunja Mladenić, "MTI: A method for user identification for multitouch displays", *Int. j. human-comput. stud.*, vol. 71, no. 6, pp. 691-702, 2013.
2. Bojan Blažica, Daniel Vladušič, Dunja Mladenić, "HDCMD: a clustering algorithm to support hand detection on multitouch displays", In: Human factors in computing and informatics: proceedings, *Lect. Notes Comput. Sci.*, vol. 7946, pp. 803-814, 2013.
3. Bojan Blažica, Daniel Vladušič, Dunja Mladenić, "A personal perspective on photowork: implicit human-computer interaction for photo collection management", *Personal and ubiquitous computing*, vol. 17, iss. 8, pp. 1787-1795, 2013.
4. Frédéric Chazal, Leonidas J. Guibas, Steve Oudot, Primož Škraba, "Persistence-based clustering in riemannian manifolds", *J. ACM*, vol. 60, iss. 6, art. 41, 2013.
5. Iztok Kosem, Polona Gantar, Simon Krek, "Avtomatizacija leksikografskih postopkov", In: *Jezikovne tehnologije*, (Slovenščina 2.0, Tematska številka, vol. 1, no. 2), Tomaž Erjavec, ed., Jerneja Žganec Gros, ed., Ljubljana, Trojina, Institute for Applied Slovene Studies, 2013, pp. 139-164.
6. Simon Krek, "Korpusne metode in njihov odsev v jezikoslovnih teorijah 20. stoletja", *Slovenščina 2.0*, no. 1, pp. 4-23, 2013.
7. Gregor Leban, "Information visualization using machine learning", *Informatica (Ljublj.)*, vol. 37, no. 1, pp. 109-110, 2013.
8. Inna Novalija, Dunja Mladenić, "Applying semantic technology to business news analysis", *Appl. artif. intell.*, vol. 27, no. 6, pp. 520-550, 2013.
9. Iztok Sarnik, "Index data structure for fast subset and superset queries", In: Availability, reliability, and security in information systems and HCI: proceedings, *Lect. Notes Comput. Sci.*, vol. 8127, pp. 134-148, 2013.
10. Tadej Štajner, Tomaž Erjavec, Simon Krek, "Razpoznavanje imenskih entitet v slovenskem besedilu", In: *Jezikovne tehnologije*, (Slovenščina 2.0, Tematska številka, vol. 1, no. 2), Tomaž Erjavec, ed., Jerneja Žganec

Gros, ed., Ljubljana, Trojina, Institute for Applied Slovene Studies, 2013, pp. 58-81.

11. Tadej Štajner, Inna Novalija, Dunja Mladenić, "Informal multilingual multi-domain sentiment analysis", *Informatica (Ljublj.)*, vol. 37, no. 4, pp. 373-380, 2013.
12. Nenad Tomašev, Dunja Mladenić, "Class imbalance and the curse of minority hubs", *Knowl.-based syst.*, vol. 53, pp. 157-172, 2013.
13. Nenad Tomašev, Jan Rupnik, Dunja Mladenić, "The role of hubs in cross-lingual supervised document retrieval", In: Advances in knowledge discovery and data mining: 17th Pacific-Asia Conference, PAKDD 2013, Gold Coast, Australia, April 14-17, 2013: proceedings. Part II, *Lect. Notes Comput. Sci.*, 7819, pp. 185-196, 2013.
14. Darinka Verdonik, Iztok Kosem, Ana Zwitter Vitez, Simon Krek, Marko Stabej, "Compilation, transcription and usage of a reference speech corpus: the case of the Slovene corpus GOS", *Language resources and evaluation*, vol. 47, iss. 4, pp. 1031-1048, Dec. 2013.
15. B. Wang, P. Rosen, Primož Škraba, H. Bhatia, Vincenzo Pascucci, "Visualizing robustness of critical points for 2D time-varying vector fields", In: Proceedings of the 15th EuroVis 2013, The European Conference on Visualization, June 17-21, 2013, Leipzig, Germany, *Comput. Graph. Forum*, vol. 32, no. 3, pt. 2, pp. 221-230, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Ashton Anderson, Daniel P. Huttenlocher, Jon Kleinberg, Jurij Leskovec, "Steering user behavior with badges", In: *WWW 2013*, 22nd World Wide Web Conference, 13th-17th May 2013, Rio de Janeiro, Brazil, New York, ACM, = Association for Computing Machinery, 2013, pp. 95-106.
2. Luka Bradeško, Marko Grobelnik, Andreas Harth, Achim Rettinger, Sebastian Speiser, "The architecture of future automotive applications based on web technologies", In: *Shift into high gear on the web: Web and Automotive W3C Workshop, 14-15 November 2012, Rome, Italy*, [S. l., s. n.], 2013, 5 pp..
3. Lorand Dali, Blaž Fortuna, Jan Rupnik, "Personalized query auto-completion for news search", In: *Zbornik 16. mednarodne*

- multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 159-163.*
4. Cristian Danescu, Niculescu Mizil, Robert West, Dan Jurafsky, Jurij Leskovec, Christopher Potts, "No country for old members: user lifecycle and linguistic change in online communities", In: *WWW 2013, 22nd World Wide Web Conference, 13th-17th May 2013, Rio de Janeiro, Brazil, New York, ACM, = Association for Computing Machinery, 2013, pp. 307-318.*
 5. Manuel Gomez-Rodriguez, Jurij Leskovec, Bernhard Schölkopf, "Structure and dynamics of information pathways in online media", In: *Proceedings of the Sixth ACM International Conference on Web Search and Data Mining, WSDM 2013, February 04-08, 2013, Rome, Italy, New York, ACM, 2013, pp. 23-32.*
 6. Zala Herga, Luka Bradeško, "Call centre knowledge acquisition and decision support prototype", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 151-154.*
 7. Mario Karlovčec, Dunja Mladenič, "Web application for generating subnetworks of Slovenian research collaboration", In: *Proceedings, 5th International Conference on Information Technologies and Information Society [also] ITIS 2013, Dolenjske toplice, 7-9 november 2013, Zoran Levnjaci, ed., Novo mesto, Fakulteta za informacijske študije, 2013.*
 8. Blaž Kažič, Jan Rupnik, "Sensor-based single-user activity recognition", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 180-183.*
 9. Klemen Kenda, Jasna Škrbec, Maja Škrjanc, "Usage of the Kalman filter for data cleaning of sensor data", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 172-175.*
 10. Myung-hwan Kim, Jurij Leskovec, "Nonparametric multi-group membership model for dynamic networks", In: *2013 Workshop book: NIPS 2013, Neural Information Processing Systems Workshop, December 5-10, 2013, Lake Tahoe, Nevada, US, [S. l.], Neural Information Processing System Foundation, 2013, 9 pp.*
 11. Iztok Kosem, Polona Gantar, Simon Krek, "Automation of lexicographic work: an opportunity for both lexicographers and crowd-sourcing", In: *Electronic lexicography in the 21st century: thinking outside the paper: proceedings of eLex 2013 Conference, 17-19 October 2013, Tallinn, Estonia, Iztok Kosem, ed., et al, Ljubljana, Trojina, Institute for Applied Slovene Studies, Tallinn, Eesti Keele Instituut, 2013, pp. 32-48.*
 12. Simon Krek, Helena Dobrovoljc, Kaja Dobrovoljc, Damjan Popič, "Online style guide for Slovene as a language resources hub", In: *Electronic lexicography in the 21st century: thinking outside the paper: proceedings of eLex 2013 Conference, 17-19 October 2013, Tallinn, Estonia, Iztok Kosem, ed., et al, Ljubljana, Trojina, Institute for Applied Slovene Studies, Tallinn, Eesti Keele Instituut, 2013, pp. 379-391.*
 13. Gregor Leban, "Semantic tools for improving software development in open source communities", In: *Proceedings of the ISWC 2013 posters & demonstrations track within the 12th International Semantic Web Conference, October 23, 2013, Sydney Australia, (CEUR workshop proceedings, vol. 1035), Eva Blomqvist, ed., Tudor Groza, ed., [S. l.], CEUR-WS, cop. 2013, pp. 97-100.*
 14. Julian John McAuley, Jurij Leskovec, "From amateurs to connoisseurs: modeling the evolution of user expertise through online reviews", In: *WWW 2013, 22nd World Wide Web Conference, 13th-17th May 2013, Rio de Janeiro, Brazil, New York, ACM, = Association for Computing Machinery, 2013, pp. 897-908.*
 15. Inna Novalija, Gregor Leban, "Applying NLP for building domain ontology: fashion collection", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 147-150.*
 16. Rodoljub Petrović, Lorand Dali, Dunja Mladenič, "Click prediction in mobile display advertising based on HTML5 features", In: *ITI 2013: 35th International Conference on Information Technology Interfaces, June 24-27, 2013, Cavtat/Dubrovnik, Croatia, (ITI ... (Tisak)), 35th International Conference on Information Technology Interfaces, June 24-27, 2013, Cavtat/Dubrovnik, Croatia, Vesna Lužar - Stiffler, ed., Iva Jarec, ed., Zagreb, University of Zagreb, University Computing Centre, 2013, pp. 303-308.*
 17. Călin Railean, Alexandra Moraru, Jan Rupnik, "Discovering pupular events from tweets", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 168-173.*
 18. Iztok Savnik, "On using object-relational technology for querying LOD repositories: [Elektronski vir]", In: *Think mind: DBKDA 2013, January 27 - February 1, 2013, Seville, Spain, Friedrich Laux, ed., Lena Strömbäck, ed., [S. l., s. n., 2013], pp. 39-44.*
 19. Dafna Shahaf, Jaewon Yang, Caroline Suen, Jeff Jacobs, Heidi Wang, Jurij Leskovec, "Information cartography: creating zoomable, large-scale maps of information", In: *Proceedings of the 19th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, August 11-14, 2013, Chicago, IL, USA, Inderjit S. Dhillon, ed., New York, ACM, 2013, pp. 1097-1105.*
 20. Janez Starc, Dunja Mladenič, "Semi-automatic construction of pattern rules for translation of natural language into semantic representation", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 155-158.*
 21. Janez Starc, Dunja Mladenič, "Semi-automatic rule construction for semantic linking of relation arguments", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 176-179.*
 22. Caroline Suen, Sandy Huang, Chantat Eksombatchai, Rok Sosič, Jurij Leskovec, "NIFTY: a system for large scale information flow tracking and clustering", In: *WWW 2013, 22nd World Wide Web Conference, 13th-17th May 2013, Rio de Janeiro, Brazil, New York, ACM, = Association for Computing Machinery, 2013, pp. 1237-1248.*
 23. Maja Škrjanc, Klemen Kenda, Gašper Pintarič, "Event processing in asset management", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 164-167.*
 24. Jaka Špeh, Andrej Muhič, Jan Rupnik, "Parameter estimation for the Latent Dirichlet Allocation", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 131-136.*
 25. Nenad Tomašev, Gregor Leban, Dunja Mladenič, "Exploiting hubs for self-adaptive secondary re-ranking in bug report duplicate detection", In: *ITI 2013: 35th International Conference on Information Technology Interfaces, June 24-27, 2013, Cavtat/Dubrovnik, Croatia, (ITI ... (Tisak)), 35th International Conference on Information Technology Interfaces, June 24-27, 2013, Cavtat/Dubrovnik, Croatia, Vesna Lužar - Stiffler, ed., Iva Jarec, ed., Zagreb, University of Zagreb, University Computing Centre, 2013, pp. 184-187.*
 26. Mitja Trampuš, Flavio Fuart, Jan Berčič, Delia Rusu, Luka Stopar, Tadej Štajner, "(i)DiversiNews: a stream-based, on line service for diversified news", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 145-169.*
 27. Jaewon Yang, Julian John McAuley, Jurij Leskovec, "Community detection in networks with node attributes", In: *ICDM 2013, Danvers, IEEE = Institute of Electrical and Electronics Engineers, 2013, 10 pp.*

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Klemen Kenda, Carolina Fortuna, Alexandra Moraru, Dunja Mladenič, Blaž Fortuna, Marko Grobelnik, "Mashups for the web of things", In: *Semantic mashups: intelligent reuse of web resources*, Brigitte Endres-Niggemeyer, ed., Berlin, Heidelberg, Springer, 2013, pp. 145-169.

SCIENTIFIC MONOGRAPH

1. Drago Kladnik, Rok Ciglič, Mauro Hrvatin, Drago Perko, Peter Repolusk, Manca Volk Bahun, Simon Krek, Drago Kladnik (urednik), Drago Perko (urednik), *Slovenski eksonimi*, (Geografija Slovenije, 24), Ljubljana, Založba ZRC, 2013.

MENTORING

1. Bojan Blažica, *The inherent context awareness of natural user interfaces: a case study on multitouch displays*: doctoral dissertation, Ljubljana, 2013 (mentor Dunja Mladenić; co-mentor Daniel Vladušič).
2. Carolina Fortuna, *Dynamic composition of communication services*: doctoral dissertation, Ljubljana, 2013 (mentor Mihael Mohorčič; co-mentor Dunja Mladenić).
3. Nenad Tomašev, *The role of hubness in high-dimensional data analysis*: doctoral dissertation, Ljubljana, 2013 (mentor Dunja Mladenić).
4. Domen Šoberl, *Distributed computation of homology in wireless sensor networks*: master's thesis, Ljubljana, 2013 (mentor Neža Mramor-Kosta; co-mentor Primož Škraba).

LABORATORY FOR OPEN SYSTEMS AND NETWORKS

E-5

The main activities of the laboratory are the R&D of next-generation networks, telecommunications technologies, components and integrated systems and information-society services and applications, especially those that ensure an efficient and pervasive life-long learning concept.

In 2013 the research group implemented the research program “Future Internet Technologies: concepts, architectures, services and socio-economic issues”. Research was also carried out in the EU 7FP project “UNITE”, the “STORK 2.0” and “eSENS” projects from the CIP programme, the “SELPRAF” project from the Leonardo da Vinci programme, the “Twin Tide” project from the COST programme, and in a few national projects. The main fields of work were technologies and services in advanced, next-generation networks, security and privacy in information systems, and technology-enhanced learning. Members of the laboratory are also teaching at the undergraduate and graduate levels at the University of Ljubljana, the Jožef Stefan International Postgraduate School, and the DOBA Faculty. In 2013 they were mentors at two master theses and one diploma thesis.



Head:

Prof. Borka Jerman Blažič

Concepts, architectures, technologies and services in the future internet

In the area of the Future Internet we successfully finished the “Upgrading ICT excellence by strengthening the cooperation between research Teams in an enlarged Europe (UNITE)” project. The main goals of the project were the organization of researchers and PhD students exchange between EU research, academic and industrial organizations, the organization of targeted workshops, such as doctoral symposiums, across an enlarged Europe to build-up synergies and support networking and collaboration, and the creation of virtual communities for the institutions involved in research of the Future Internet.

Among our most important R&D results in this area in 2013 is a Future Internet collaboration platform that supports a number of advanced synchronous and asynchronous collaboration activities and services, e.g., multimedia-based communication, public/private chat, screen sharing, voting, recording, skills and competencies-based content tagging, efficient P2P-based content distribution, and authentication with standard e-identity credentials or graphical passwords on mobile devices. The platform's building blocks are based on open-source technologies, such as OpenMeetings and Matterhorn, and the technologies we developed in collaboration with other partners in a number of EU projects, such as P2P-Next (NextShare), OpenScout or STORK. The platform has been successfully tested in a commercial environment.

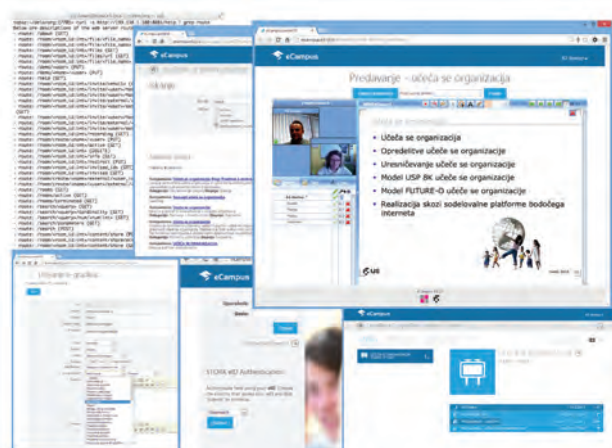


Figure 1: Future collaboration platform

Technology-enhanced learning

The general aim of the successfully finished Leonardo da Vinci LLP “Self-employment with e-learning based Practice Firms (SELPRAF)” project was to encourage people's interest in entrepreneurship through an innovative SELPRAF Training Programme for the acquisition of the four key competences (communication in the mother tongue, communication in foreign languages, digital competence, and sense of initiative and entrepreneurship) and, on the other hand, to enable the inclusion of the unemployed in practice firms and to encourage self-employment. In 2013 we conducted a pilot SELPRAF training, which was attended by 227 unemployed people in Slovenia and Croatia. They have carried out more than 4,500 hours of distance learning and the top 48 trainees were later included in the practice firms where they trained real business. According to the very positive feedback from the trainees, the innovative educational program SELPRAF, based on know-how and the transfer of practical experience, can achieve already in the medium-term perspective more stimulating working environment and stronger interest for entrepreneurship.

The main objective of the COST project “Towards the Integration of Transectorial IT Design and Evaluation (TwinTide)” that also ended in 2013 was to harmonize and integrate research findings and achievements with practice during the process of designing and evaluating information technologies across various sectors and disciplines. In November 2013 we co-organized in Bled an international TwinTide autumn training school TUTUREM'2013 for PhD

students from the HCI field. The overarching goal of TUTOREM was to improve the participants' understanding of significant research methods commonly or increasingly used in the field of HCI. Such an enhanced understanding will enable them to select and combine appropriate research methods for their specific HCI projects and to contextualise them without unintended impacts on validity. The TUTOREM School was attended by 32 PhD students and 7 professors from all over Europe.



Figure 2: TUTOREM school for Ph.D. students

In 2013 we successfully finished two bilateral scientific cooperation projects: the first one with the Republic of Cyprus in the field of creative information spaces for problem-based learning and the second one with the Republic of Serbia within the scope of applications of workflow management technology in e-learning systems. The results of the joint research have already been published in a scientific journal with an SCI impact factor and at three international conferences. Furthermore, we continued with the analysis of business games suitable for e-learning and education and presented the results at two conferences.

We were also successful in obtaining new projects from the EU's 7FP. "Scalable cost-effective facilitation of professional identity transformation in public employment services (**EmployID**)" was the highest ranked project proposal among more than 100 proposals in the whole field of technology enhanced learning. The main goal of the project that will start in February 2014 is to support and facilitate the learning process of PES (Public Employment Services) practitioners in their professional identity development by the efficient use of technologies to provide advanced coaching, reflection, networking and learning support services.

Security, dependability and privacy in information systems

The provision of security and privacy services is crucial for the modern information society. In 2013 our activities in this field were focused on R&D in security context-aware mechanisms and services for advanced systems and networks, such as pervasive systems, e-identity-based services, trust and reputation management, cloud computing security, and security economics.

Ubiquitous social systems impose several challenges with respect to traditional security. A security system applicable for such environments should enable open interaction between entities and devices and protect resources in proportion to their importance and according to the security context. We proposed a conceptual model of security context that takes into account related social aspects and defines a set of concepts at the appropriate level of abstraction. The model promises to facilitate the specification, management and reuse of security policies in complex and dynamic environments.

Online trust systems aim to translate the role that trust has in the traditional world onto network-based systems. In a scientific paper in a journal with an SCI impact factor we determined the systemic features of trust and introduced a novel framework of design properties. We described the systemic properties that lack in the current technical solutions, and incorporated social factors into the design guidelines of trust systems. This paper is the first study applying fundamental social science principles from General Systems Theory and case-study research for the purpose of theory building and the evaluation of technical human-centric solutions.

The Laboratory for Open Systems and networks is a member of two large-scale pilot projects, STORK and eSENS, that are developing a pan-European infrastructure for cross-border e-services. The goal of a "Secure identity across borders linked 2.0 (STORK 2.0)" project with 58 partners from 19 European countries is to enable e-identity-based services across borders in the fields of e-academia, e-banking, public services for business, and e-health. The project that started in 2012 will demonstrate interoperable services in real-life settings and validate common specifications, standards and building blocks, exploring scenarios to address challenging legal and governance issues (across borders, application domains and different sectors) decisively pushing the lines for the wider uptake of eID in Europe. Our main activities in 2013 included setting up a common infrastructure on a European level and the implementation of three e-academia services, in particular a virtual learning environment, an anonymous electronic survey service, and a job-selection service. The "Electronic Simple European Networked Services (eSENS)" project that started in 2013 will consolidate the building blocks of the existing large-scale pilots, including STORK 2.0, focusing strongly on the core building blocks such as eID, eDocuments, e-Delivery, and e-Signatures. Our laboratory is leading project activities on user attributes provision and aggregation and role management.

Electronic identity-related research activities were also part of the "Cloud assisted services (CLASS)" project. The centre connects a number of Slovenian companies, universities and research institutions with an aim to develop services and products in the area of cloud computing. The most important result of our activities in 2013 is a prototype of a single sign-on solution that works across a variety of cloud platforms (OpenStack, VMware). The solution

Electronic identity-related research activities were also part of the "Cloud assisted services (CLASS)" project. The centre connects a number of Slovenian companies, universities and research institutions with an aim to develop services and products in the area of cloud computing. The most important result of our activities in 2013 is a prototype of a single sign-on solution that works across a variety of cloud platforms (OpenStack, VMware). The solution

enables the reduction of certain security risks, while providing the possibility of the centralised control of users. It has already been well received among the open-source developers and companies in the field of cloud computing.

In the area of security-related research activities we continued with research on security economics, where we analyse the assessment of the appropriate investment that is economically affordable and provides enough protection for enterprise information systems. The result, i.e., an updated approach to the quantification of the necessary investment and a recommendation for a standard approach to security-information investment assessment, has been published in a scientific journal "Engineering management journal" with an SCI impact factor.

The laboratory was very successful in 2013 in obtaining new EU projects from 7FP and the ISEC programme also in the security field. The main goal of the **COURAGE**, **REDIRNET** and **DFET** projects is to deliver a research agenda for cyber crime and cyber terrorism, provide a decentralized framework for interoperability for first responders' systems, and develop a cloud-based cybercrime and forensics training and evaluation environment. All three projects will start with their activities at the beginning of 2014.

Science promotion

In September 2013 the Laboratory for Open Systems and Networks successfully organized Researcher's Night 2013 with the goal to promote science, scientists and their results. The event was organized in collaboration with Faculty of Information Studies Novo mesto and the National Institute of Biology within the 7FP "REsearchers for NAture preservation and TEChnology use for the benefit of the society (RENATECH)" project. "Researchers contributing to the nature preservation and the technology applications for the benefit of the society" was the major focus of the Researcher's Night 2013 in Slovenia. In order to reach the specific objective of bringing researchers closer to the public at large the Researcher's Night was organized at different locations in Ljubljana (Congress Square, National Institute of Biology, Šentvid High School, Ljubljansko barje Landscape Park), Novo mesto (Faculty of Information Studies) and Piran (Marine Biology Station). The event was widely recognized by the broader society, which proved that there is definitely a lack of projects and events with similar contents and that scientists are keen to share their experience with their colleagues and in this way stimulate the young who are just at the beginning of their careers. The estimated total number of visitors at all venues was around 6000. The event received great attention in national media (national TV and radio, POP TV, etc.).



Figure 3: Researcher's Night 2013

Some outstanding publications in the past three years

1. Bojanc, R., Jerman-Blažič, B., Tekavčič, M.: Managing the investment in information security technology by use of a quantitative modeling. *Inf. process. manage.*, 2012, vol. 48, no. 6, 1031-1052
2. Jerman-Blažič, B.: Four scenarios for future evolution of the internet. *IEEE technology & society magazine*, ISSN 0278-0097, 2011, vol. 30, no. 4, 39-46
3. Mihajlov, M., Jerman-Blažič, B.: On designing usable and secure recognition-based graphical authentication mechanisms. *Interact. comput.* [Print ed.], 2011, vol. 23, no. 6, 582-593

Organization of conferences, congresses and meetings

1. The 2013 Researcher's Night, RENATECH Project, 27. 9. 2013
2. Organisation of "TwinTide" Training School, Bled, Slovenia, 4.-8. 11. 2013

INTERNATIONAL PROJECTS

1. 7FP - UNITE; Upgrading ICT Excellence by Strengthening Cooperation between Research Teams in an Enlarged Europe
European Commission
Prof. Borka Džonova Jerman Blažič
2. 7FP - ReNATECH; REsearchers for NAture preservation and TEChnology use for the benefit of the society
European Commission
Prof. Borka Džonova Jerman Blažič
3. STORK 2.0; Secure idenTity acrOss boRders LinKed 2.0
European Commission
Prof. Borka Džonova Jerman Blažič
4. CIP-e-SENS; Electronic Simple European Networked Services
European Commission
Prof. Borka Džonova Jerman Blažič
5. COST IC0904; Towards the Integration of Trans-sectorial IT Design and Evaluation
COST Office
Matija Pipan, M. Sc.
6. Creative Multimodal Information Spaces for Problem-based Learning
Slovenian Research Agency
Asst. Prof. Tanja Arh
7. Application of Workflow Management Technology in E-learning Systems
Slovenian Research Agency
Asst. Prof. Tanja Arh

RESEARCH PROGRAM

1. Future Internet Technologies: Concepts, Architectures, Services and Socio-Economic Issues
Prof. Borka Džonova Jerman Blažič

R&D GRANTS AND CONTRACTS

1. Future Internet Collaboration Platform
Prof. Borka Džonova Jerman Blažič
2. Cloud Assisted Services: CC CLASS
Prof. Borka Džonova Jerman Blažič
3. LdV - SELPRAF; Self-employment with e-Learning based Practise Firms
Asst. Prof. Tanja Arh

VISITORS FROM ABROAD

1. Dr. Andri Ioannou, Prof. Dr. Panayiotis Zaphiris, Christina Vasiliou, Cyprus University of Technology, CUT, Limassol, Cyprus, 17.-20. 10. 2013

STAFF

Researchers

1. Asst. Prof. Tanja Arh
2. Asst. Prof. Rok Bojanc*
3. **Prof. Borka Džonova Jerman Blažič, Head**
4. Asst. Prof. Tomaž Klobučar

Postdoctoral associate

5. Dr. Dušan Gabrijelčič

Postgraduates

6. Andrej Jerman Blažič, M. Sc.
7. Vladimir Jovanovikj, B. Sc.

8. Maks Mržek, B. Sc.
9. Tanja Pavleska, B. Sc.
10. Matija Pipan, M. Sc.
11. Svetlana Sapelova

Technical and administrative staff

12. Tatjana Martun, B. Sc.

Note:

* part-time JSI member

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Tanja Ažderska, Borka Jerman-Blažič, "A holistic approach for designing human-centric trust systems", *Syst. pract. action res. (Dordr., Online)*, vol. 26, no. 5, pp. 417-450, 2013.
2. Rok Bojanc, Borka Jerman-Blažič, "A quantitative model for information-security risk management", *Eng. manag. j.*, vol. 25, no. 3, pp. 25-37, 2013.

REVIEW ARTICLE

1. Tomaž Klobučar, "Sodobne e-izobraževalne tehnologije", *Mednarodno inovativno poslovanje*, vol. 5, no. 1, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Rok Bojanc, "Interoperabilna platforma z enotno vstopno točko", In: *Dvajset let pozneje: zbornik prispevkov*, 20. konferenca Dnevi slovenske informatike, Portorož, 15.-17. april 2013, Tomaž Gornik, ed., 1. izd., Ljubljana, Slovensko društvo Informatika, 2013, pp. 1-10.
2. Cormac Callanan, Borka Jerman-Blažič, Heins Dries-Ziekenheiner, "Empirical assessment of data protection and circumvention tools availability in mobile networks", In: *Proceedings, The Second International Conference on Cyber Security, Cyber Peacefare and Digital Forensic, CyberSec2013*, March 4-6, 2013, Kuala Lumpur, Kuala Lumpur, The Asia Pacific University of Technology and Innovation, 2013, pp. 206-220.
3. Andrej Jerman Blažič, Tanja Arh, "Business simulation game - an innovative pedagogical approach in business environment", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference*, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 136-141.
4. Andrej Jerman Blažič, Tanja Arh, "Immersive business simulation games: an innovative pedagogical approach to e-learning and education", In: *Electric dreams: proceedings*, 30th Ascilite Conference, 1-4 December 2013, Sydney, H. Carter, ed., M. Gosper, ed., J. Hedberg, ed., Sydney, Aacuarie University, 2013.

5. Andrej Jerman Blažič, Tanja Arh, "Resne poslove igre: nov pristop k učenju projektnega menedžmenta: a new approach to project management learning", In: *Izzivi gospodarskega razvoja - inovativni projektni management: zbornik prireditve, Ljubljana, 20. in 21. maj 2013*, Ljubljana, GZS, Zbornica osrednjeslovenske regije, 2013, pp. 99-104.
6. Vana Kamtsiou, Tomaž Klobučar, "Integrating roadmapping and disagreement management methodologies for coordinating development of competency-driven education standards: the ICOPER Case", In: *Technology management in the IT-driven services: PICMET '13 conference*, Portland International Center for Management of Engineering and Technology, July 28 - August 1, 2013, San Jose, California, USA, Portland, PICMET, 2013, pp. 2236-2247, 2013.
7. Matija Pipan, Bojan Srdjević, Julija Lapuh Bele, Zorica Srdjević, "Comparison of decision making results in case of LMS selection", In: *Pametna organizacija: talenti, vitka organiziranost, internet stvari: zbornik 32. mednarodne konference o razvoju organizacijskih znanosti: high potentials, lean organization, internet of things: proceedings of the 32nd International Conference on Organizational Science Development*, 32. mednarodna konferenca o razvoju organizacijskih znanosti, 20.-22. 3. 2013, Portorož, Slovenija, Zvone Balantič, ed., et al, Kranj, Moderna organizacija, 2013, pp. 847-854.
8. Christina Vasiliou, Andri Iannou, Tanja Arh, Panayiotis Zaphiris, Tomaž Klobučar, "Technology enhanced problem based learning", In: *Pametna organizacija: talenti, vitka organiziranost, internet stvari: zbornik 32. mednarodne konference o razvoju organizacijskih znanosti: high potentials, lean organization, internet of things: proceedings of the 32nd International Conference on Organizational Science Development*, 32. mednarodna konferenca o razvoju organizacijskih znanosti, 20.-22. 3. 2013, Portorož, Slovenija, Zvone Balantič, ed., et al, Kranj, Moderna organizacija, 2013, pp. 1187-1195.
9. Nikola Vitković, Miodrag Manić, Miroslav Trajanović, Dragan Mišić, Milorad Mitković, Tanja Arh, Matija Pipan, "eLearning system for medical education based on the geometrical models of human bones and fixators", In: *Proceedings, eLearning 2013, The Third International Conference on e-Learning*, Belgrade, September 26-27, 2013, Danijela Milošević, ed., Belgrade, Metropolitan University, 2013, pp. 10-14.
10. Srečo Zakrajšek, Tanja Arh, "Kako do dobrih idej za uspešne projekte?", In: *Izzivi gospodarskega razvoja - inovativni projektni management: zbornik prireditve, Ljubljana, 20. in 21. maj 2013*, Ljubljana, GZS, Zbornica osrednjeslovenske regije, 2013, pp. 131-138.

MENTORING

1. Blaž Ivanc, *Modelling of information attacks on critical infrastructure by using an enhanced structural model*: master's thesis, Ljubljana, 2013 (mentor Tomaž Klobučar).

2. Frančiška Avbelj, *Establishment of e-learning for health and safety at work*: master's thesis, Maribor, 2013 (mentor Tomaž Klobučar).

DEPARTMENT OF COMMUNICATION SYSTEMS

E-6

The core activities of the Department of Communication Systems comprise the research, development and design of next-generation telecommunication networks, technologies and services; wireless communication, embedded and sensor systems; and new procedures and algorithms for parallel and distributed computing. Within these activities our research work includes the development of the methods and software tools for the modelling, simulation, analysis and synthesis of communication systems, computer simulations supporting biomedical procedures and specialised equipment and procedures for advanced bio-signal processing and interpretation.

The research and development activities at the department are carried out in the framework of the *Communication Technology Laboratory (CTL)*, the *Parallel and Distributed Systems Laboratory (PDSL)* and the *Networked Embedded Systems Laboratory (NESL)*. The research work of the three laboratories is complementary, which is reflected in the joint applied projects.

In 2013 the research activities within the **Communication Technology Laboratory** were concentrated on different challenges associated with access-segment technologies, enabling end-users to access new multimedia services and applications. As part of the multi-year telecommunication-systems research programme the emphasis was on research in the areas of: radio propagation, access architectures for heterogeneous wireless networks, management of radio and network resources and cognitive communications.

The investigation of the radio-signal propagation was focused on two main topics. The first topic concerns the research of the radio-signal propagation in special environments, such as long road and railway tunnels. The emphasis was on the radio-signal propagation in typical frequency bands for voice communication systems (400 MHz), high-speed data communication systems (2.4 GHz and 3.5 GHz) and low-data-rate wireless sensor networks (868 MHz and 2.4 GHz). We published the research results in the paper "A survey of radio propagation modelling for tunnels", issued in the journal *IEEE Communications Surveys and Tutorials*. The second topic, researched in cooperation with Telekom Slovenije d.d., concerns the development, implementation and testing of software modules for radiowave propagation modelling in mobile communication systems for rural and urban environments, including statistical channel models as well as channel models based on ray tracing and their integration into the open-source geographic information system (GIS). For the ray-tracing method we started research into efficient acceleration techniques using massively parallel hardware and an optimization method applicable to a wider set of problems solved by SIMD processors was proposed.

We continued the investigation of advanced concepts and technologies for a capacity increase of wireless meshed networks using network coding techniques. In particular, we focused on the development of advanced network coding algorithms and their adapted routing procedures. In order to support the performance evaluation of arbitrary network-coding algorithms on pre-determined or randomly generated topologies of wireless meshed networks, we designed and built a simulation model, which allows the performance evaluation of network coding algorithms and routing procedures on randomly generated wireless mesh network topologies.

In collaboration with European partners within the FP7 ABSOLUTE project (Aerial Base Stations with Opportunistic Links for Unexpected & Temporary Events) we participated in the design and validation of an innovative, rapidly deployable future network architecture. It should be resilient and capable of providing broadband multi-service, secure and dependable connectivity for large coverage areas affected by large-scale unexpected events (or disasters) leading to the partial or complete unavailability of the terrestrial communication infrastructure, or for temporary events requiring very high throughput and augmented network capacity. We focused on the



Head:
Asst. Prof. Mihael Mohorčič

For integration into the open-source geographic information systems GRASS, we developed and implemented a software module for the radio-wave-propagation modelling in mobile communication systems based on ray tracing.

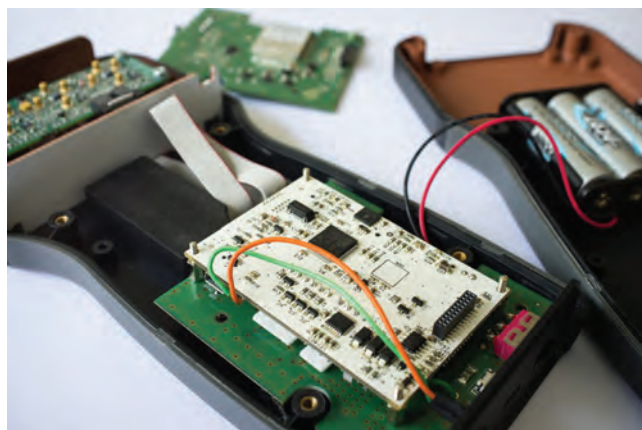


Figure 1: Air-quality monitor based on the VESNA platform.

We designed and developed new hardware and software modules and implemented new features for the VESNA platform.

For the needs of different projects we expanded the sensor network-based testbed LOG-a-TEC, supporting experimental research in radio and networking areas and in the Internet of Things applications.



Figure 2: Alphasat satellite receiver, developed at the JSI and installed in collaboration with the Joanneum Research Institute on the Hilmwarte tower in Graz, Austria.

In the frame of the EU FP7 CREW project and the FIRE initiative the LOG-a-TEC testbed is used as a real-world outdoor experimental environment for the cognitive radio and cognitive networking research.

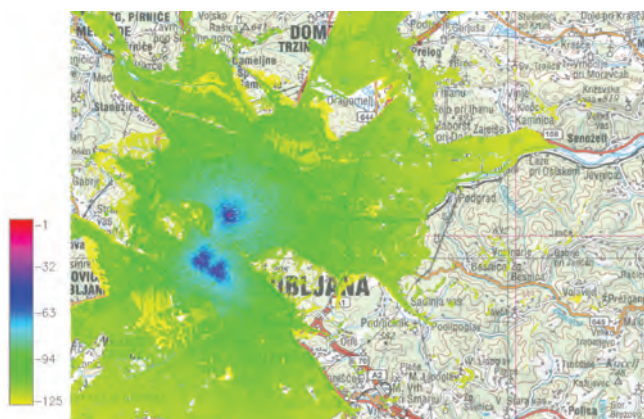


Figure 3: Radio signal coverage calculation using the in-house-developed radio coverage tool GRASS RaPlaT

development of new advanced techniques for radio-spectrum management, on the development of new network solutions and on the integration of wireless sensor networks into the emergency architecture.

In 2013 we were actively participating in several COST actions. In the COST Action IC0902 “Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Networks” we presented an original method for calculating the radio environment map and compared it with selected existing methods. With an independent chapter on low-cost experimental networks for prototyping solutions in the field of cognitive radio, we contributed to a book that will be published in 2014 by Springer. In the COST Action IC1101 “Optical Wireless Communications – An Emerging Technology” we investigated in cooperation with TU Graz the influence of weather conditions on the performance of wireless optical communication systems. In the COST Action IC1104 “Random Network Coding and Designs over GF(q)”, we are developing practical network coding procedures and evaluating them in a purpose-built simulation model. In the COST action IC1004 “Cooperative Radio Communications for Green Smart Environments” we mainly participate in working groups one and two, with topics related to radio propagation aspects and problems of the physical layer.

In the ESA PECS project SatProSi we developed a low-cost SDR-based ground station for reception of the Ka-band satellite signals from EUTELSAT HotBird 6, SES ASTRA 3B and joint ESA and Inmarsat Alphasat satellite, which is intended for long-term monitoring of the satellite carrier and modelling of the satellite channel. Software tools were also developed for a statistical analysis of the received signal data.

In the area of cognitive communications we continued research in the radio and access segments and contributed to the WUN-CogCom and FP7 CREW projects. In 2013 our research in this area was focused on stand-alone and collaborative spectrum sensing in licensed and unlicensed frequency bands and on building radio environmental maps.

In cooperation with the Department of Low and Medium Energy Physics (F2) we continued research activities that were started in previous years which were focused primarily on efficient signal-processing algorithms in high-count-rate gamma-ray spectrometry.

In the **Parallel and Distributed Systems Laboratory**, we successfully continued interdisciplinary research work in the framework of the program group that also includes the Machine Vision Laboratory from the Faculty of Electrical Engineering and the Laboratory for Algorithms and Data Structures from the Faculty of Computer and Information Science, both from the University of Ljubljana. We were heavily involved in research within the research program Parallel and Distributed Computing and also in other research projects. Our cooperating researchers also come from industry (Turboinstitut d.d. and Xlab d.o.o.) and from the medical sphere (the University Clinical Center Ljubljana).

We investigated computer algorithms for efficient implementation on parallel and distributed computers, testing them on a research computer cluster that is stationed in our department facilities, and on a cloud recently installed in cooperation with the Faculty of Computer and Information Science of the Ljubljana University and Turboinstitut d.d. In addition to demanding computations, we also paid attention to distributed large data storage. We continued investigations in the field of wireless sensor networks based on the theory of parallel and distributed computing and communication.

We developed new parallel numerical algorithms, e.g., meshless methods, which are local and, hence, efficiently executable on parallel computers. With these methods we can simulate physical phenomena, e.g., heat and fluid flows, PN junctions and molecular dynamics in realistic conditions. We developed software for simulating biological systems, e.g., lipid membranes and biomedical procedures, such as post-surgical cryotherapy and RF, and cryo-ablation of the heart. We parallelized multi-criterion optimizations and began to investigate how to efficiently integrate measurement results, simulation results and optimization methods, which will enable us to predict biological parameters that are hard to measure in a non-invasive manner.

We evaluated a new methodology for synthesising the standard ECG from a small number of differential measurements. We investigated possible options for an analysis of large signal sets with the human auditory system

(sonification). We investigated possible options for the detection of respiratory sinus arrhythmia (RSA) in the ST interval. We developed a new method for measuring the variability of the ST interval with a sub-millisecond resolution. Together with neurologists from the University Clinical Center Ljubljana, we continued equipment upgrading and measurements for the NeuroECG.

In the area of cardiology we have fortuitously documented a spontaneous cardio-inhibitory syncope using a high-precision 31-channel body-surface ECG measurement, which is probably a unique measurement of this type. Detailed analysis of the atrial activity (P waves) in this recording has shown that a functional pacemaker area exists outside the sinoatrial node. The activity of this area emerged with a profound influence of the autonomic nervous system on the sinoatrial node. After a few heart beats the activity of this area ceased causing the syncope.

We collaborated with the Laboratory for Molecular Modelling at the National Institute of Chemistry, and parallelized and consequently significantly speeded up their web service ProBiS. We then continued the successful collaboration by developing a new parallel algorithm for finding the maximum clique in undirected graphs. Finding the maximum clique in a graph is a NP-full problem, which is an important sub-problem in the problem of finding similarities between molecules.

In a project sponsored by the Marine Biological Station (MBP) from Piran we parallelized the software package NAPOM (North Adriatic Princeton Ocean Model). NAPOM represents the central part of the prognostic software system for the north Adriatic Sea. Its parallelization is the first step towards its modernization, through which MBP wishes to increase the model resolution and thus increase the prognostic capabilities on the Slovenian part of the Adriatic Sea.

In the field of formal methods for discrete systems development, we investigated the synthesis, also such with global optimization, of complete test suites for final state machines, also for the needs of distributed testing, for non-standard conformance relations and for non-standard assumptions about the properties of the automaton under test.

In 2013 the **Networked Embedded Systems Laboratory** mainly focused on research and development in the areas of the Internet of Things and cognitive communications. The emphasis was on the vertical integration of different wireless sensor and communication network technologies with semantic technologies in support of the autonomous search and composition of sensors and sensor data, as well as on the development of new applications using various machine-learning and decision-making algorithms. These activities were mainly conducted within the basic research project "Advanced procedures for interactive composition of sensor networks" and the EU FP7 Network of Excellence PlanetData.

The modular and fully flexible platform VESNA for wireless sensor networks, developed as the core building block for several research and applied projects, was complemented with a set of new modules and new features in existing modules, including radio spectrum sensing in the UHF and ISM frequency bands within the EU FP7 CREW project, a suite of motion, location, presence and ambient sensors within the national competence centre KC OpComm, a framework for the semantic description of sensor node functionalities and status, wired and wireless gateway capabilities for internet connectivity or interaction with other devices, etc. A variety of supported features, protocols and technologies, together with an arbitrary combination of developed hardware and software modules, make the VESNA platform well suited for the implementation of an experimental research sensor networks infrastructure, the deployment of pilot applications, the validation of usage scenarios and the development of end-user solutions.

We compared the calculation complexities of different meshless methods for solving a diffusion equation and concluded that strong formulated approaches are computationally more efficient than weak formulations.

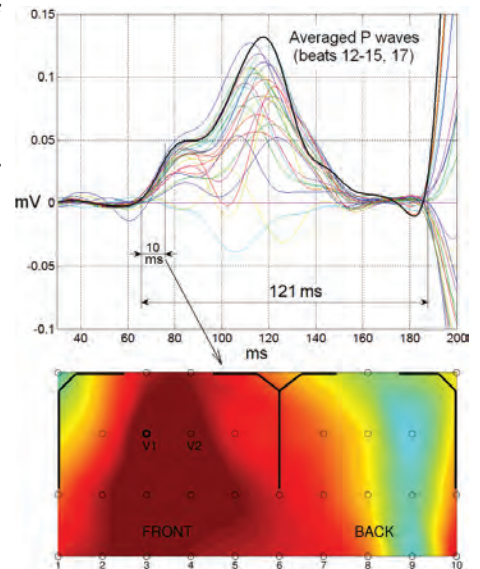


Figure 4: Body surface 31-channel ECG recording shows electrical activity (P waves) of the atria just before the emergency of spontaneous cardio-inhibitory syncope (upper panel). Colour presentation of the electrical potential on the body surface, 10 ms after the start of the activity in the atria (lower panel). The positions of the electrodes are denoted by small circles.

We developed a prototype wireless electrode of bio-potentials from the body surface for the concurrent measurements of the ECG and the respiration rate.

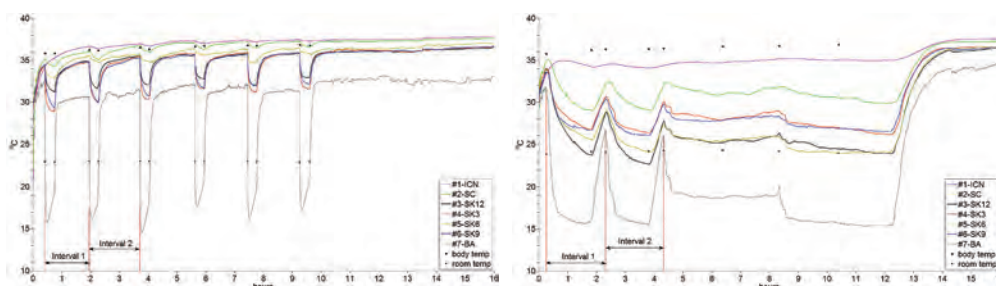


Figure 5: In-vivo measurements of average temperatures of all patients during cooling treatment in Group A with the gel-pack (left) and Group B with the cTreatment® (right). Abbreviations: ICN - intercondylar notch, SC - subcutaneous, SK - skin (12 - anterior, 3 - medial, 6 - posterior, 9 - lateral), BA - bandage.

We synthesised, with a high reliability, a standard 12-lead ECG from three bipolar wireless electrodes.

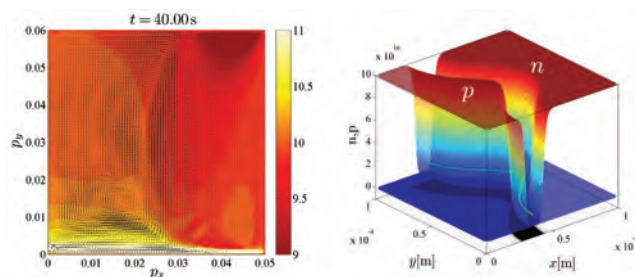


Figure 6: Results of a numerical simulation of binary material solidification (Sn-10%Pb) (left) where the concentration and velocity fields are presented at the moment when instabilities appear and the simulation of the PN junction, where the density distribution of electric carriers in a semiconductor device is presented.

the execution of experiments and the gathering of sensor measurements data is performed via a web application running on one of our servers. In the current setup built for the FP7 CREW project the LOG-a-TEC testbed consists of more than 50 nodes in two clusters and allows the execution of experimentally-driven research in the areas of spectrum sensing in licensed and unlicensed frequency bands, cognitive radio and cognitive networking. As a part of the CREW testbeds federation this part of LOG-a-TEC also represents one of the FIRE facilities, i.e., the only one supporting the investigation of horizontal and vertical radio-spectrum-sharing methods in a real-world outdoor environment and being particularly well suited for experiments in TV white spaces. The LOG-a-TEC testbed has been complemented with another location at the JSI, where VESNA platforms are equipped with Contiki OS and intended for experimentation with cognitive networking on MAC and higher layers using the ProtoStack tool for remote composition, reconfiguration and reprogramming of the CRIME protocol stack.

In collaboration with the Municipality of Logatec and Komunalno podjetje Logatec we upgraded a large-scale outdoor wireless sensor network LOG-a-TEC experimental testbed. The testbed is based on the VESNA platform and equipped with a set of sensors and communication interfaces, as required by a given project. The sensor nodes' firmware management, the execution of experiments and the gathering of sensor measurements data is performed via a web application running on one of our servers. In the current setup built for the FP7 CREW project the LOG-a-TEC testbed consists of more than 50 nodes in two clusters and allows the execution of experimentally-driven research in the areas of spectrum sensing in licensed and unlicensed frequency bands, cognitive radio and cognitive networking. As a part of the CREW testbeds federation this part of LOG-a-TEC also represents one of the FIRE facilities, i.e., the only one supporting the investigation of horizontal and vertical radio-spectrum-sharing methods in a real-world outdoor environment and being particularly well suited for experiments in TV white spaces. The LOG-a-TEC testbed has been complemented with another location at the JSI, where VESNA platforms are equipped with Contiki OS and intended for experimentation with cognitive networking on MAC and higher layers using the ProtoStack tool for remote composition, reconfiguration and reprogramming of the CRIME protocol stack.

Our research work in the frame of the national competence centre KC OpComm, aiming at the development of an open communication platform for the development of new types of services and applications for the Future Internet, was concentrated on the provision of data and context information from sensor networks to management services and applications. To this end, we continued developing different VESNA platform modules, investigating procedures for the pre-processing of data and metadata, and developing the required communication protocols and interfaces for the platform. Related

to these activities we developed sensoric support for an asset-management application and remote monitoring of the photovoltaic power plant at Telekom Slovenije.

In the area of remote monitoring we continued the work in the EU FP7 project BalkanGEONet concerned with the inclusion of all Balkan countries into GEO. In the area of wireless sensor networks we continued two FP7 projects. In the ABSOLUTE project our role is to integrate a VESNA-based wireless sensor network in the emergency communications network architecture. The aim is to provide easily deployable sensor network for in-situ fixed or participatory monitoring of post-disaster parameters as well as for the spectrum sensing needed to support the ad-hoc establishment of the ABSOLUTE communication system without causing harmful interference to coexisting communication systems. In the CITI-SENSE project, which is concerned with the establishment of sensor-based Citizens' Observatory Community for improving the quality of life in cities, our focus was mainly on providing the

VESNA-based solution for air-quality monitoring. As part of this we were developing modules with gas, particle matter and other ambient related sensors, which would be used for indoor and outdoor environment monitoring.

In 2013, we started two technology development projects financed by the Ministry of Economic Development and Technology, namely "Smart camper" and "Smart home". In the first one, in collaboration with the company Adria Mobil, we started developing sensor and communication technologies for the intelligent remote management of motorhomes. In the second project, together with the company Cosylab, we started developing sensor and communication technologies for smart buildings, with an emphasis on monitoring the generation and consumption of electricity.

The Networked Embedded Systems Laboratory and its research and development activities also take part in the SensorLab group, which was established by the Department of Communication Systems and the Laboratory of Artificial Intelligence.

Some outstanding publications in the past year:

1. Hrovat, A., Kandus, G., Javornik, T.: A survey of radio propagation modeling for tunnels. IEEE Communications surveys and tutorials, 2013, 12 pgs., doi: 10.1109/SURV.2013.091213.00175
2. Volkov, A., Žganec Gros, J., Žganec, M., Javornik, T., Švigelj, A.: Modulated acquisition of spatial distortion maps. Sensors, ISSN 1424-8220, 2013, vol. 13, no. 8, 11069-11084, doi: 10.3390/s130811069

- **We fortuitously documented a unique measurement of spontaneous cardioinhibitory syncope by high-precision 31-channel body-surface ECG.**
- **We parallelized and thus speeded up two software packages that are in active use, one in the Marine Biological Station and one in the National Institute of Chemistry.**
- **We improved a simulation model for the performance evaluation of network-coding techniques.**

3. Švigelj, A., Mohorčič, M., Franck, L., Kandus, G.. Signalling analysis for traffic class dependent routing in packet switched ISL networks. Space communications, ISSN 0924-8625, 2013, vol. 22, no. 2/4, 191–203, doi: 10.3233/SC-130015
4. Kosec, G., Zinterhof, P.: Local strong form meshless method on multiple Graphics Processing Units. CMES-Comp Model Eng. 2013;91:377–96
5. Kosec, G., Šarler, B.: Solution of a low Prandtl number natural convection benchmark by a local meshless method. Int J Numer Method H. 2013;23:22
6. Avbelj, V., Trobec, R.: A closer look at electrocardiographic P waves before and during spontaneous cardioinhibitory syncope: letter to the editor. Int. j. cardiol., 166 (2013) 3, e59–e61.
7. Rashkovska, A., Trobec, R., Avbelj, V., Veselko, M.: Knee temperatures measured in vivo after arthroscopic ACL reconstruction followed by cryotherapy with gel-packs or computer controlled heat extraction, Knee Surg Sports Traumatol Arthrosc, early publ. doi:10.1007/s00167-013-2605-x, 2013

We improved a simulation model for the performance evaluation of network-coding techniques.

Awards and appointments

1. Aleksandra Rashkovska: Special prize for innovations for economy at the 6th International Transfer Conference and Innovation Day 2013, Brdo pri Kranju, Slovenia, Smart Thermo Therapy

Patents granted

1. Bojan Likar, Robert Posel, Andreas Kalagasidis, Tomaž Javornik, Gorazd Kandus, Mihael Mohorčič, Aleš Švigelj, Janez Bešter, Andrej Kos, Miha Smolnikar, Iterative localization techniques, US8565106 (B2), US Patent Office, 22.10.2013.
2. Bojan Likar, Robert Posel, Andreas Kalagasidis, Tomaž Javornik, Gorazd Kandus, Janez Sterle, Urban Sedlar, Janez Bešter, Andrej Kos, Luka Mali, Method for self organizing network operation, US8472334 (B2), US Patent Office, 25.6.2013.

INTERNATIONAL PROJECTS

1. 7FP - PlanetData
European Commission
Asst. Prof. Mihael Mohorčič
2. 7FP - BalkanGEONet; Balkan GEO Network-Towards Inclusion of Balkan Countries into Global Earth Observation Initiatives
European Commission
Asst. Prof. Mihael Mohorčič
3. 7FP - CREW; Cognitive Radio Experimentation World
European Commission
Asst. Prof. Mihael Mohorčič
4. 7FP - ABSOLUTE; Aerial Base Stations with Opportunistic Links for Unexpected & Temporary Events
European Commission
Asst. Prof. Mihael Mohorčič
5. 7FP - CITI-SENSE; Development of Sensor-based Citizens' Observatory Community for Improving Quality of Life in Cities
European Commission
Asst. Prof. Mihael Mohorčič
6. 7FP - VHP NoE; Virtual Physiological Human Network of Excellence
European Commission
Prof. Roman Trobec
7. ESA PECS; Processing of Satellite Signals in Ka/Q-frequency Band
ESA/ESTEC.
Prof. Gorazd Kandus
8. COST IC1004; Cooperative Radio Communications for Green Smart Environments
COST Office
Asst. Prof. Tomaž Javornik
9. COST IC1101; Optical Wireless Communications - An Emerging Technology
COST Office
Prof. Gorazd Kandus
10. COST IC0906; WiNeMO; Wireless Networking for Moving Objects
COST Office
Miha Smolnikar, B. Sc.
11. COST IC0902; Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Networks
COST Office
Asst. Prof. Mihael Mohorčič
12. HiPEAC; European Network of Excellence on High Performance and Embedded Architecture and Compilation
Ghent University
Prof. Roman Trobec
13. Cellular and Finite Automata for Structure Recognition
Slovenian Research Agency
Prof. Roman Trobec
14. Advanced Technologies for Next Generations of Mobile Broadband Communication Systems
Slovenian Research Agency
Asst. Prof. Tomaž Javornik
15. Optimization of Energy Consumption in Distributed Computing Systems
Slovenian Research Agency
Prof. Roman Trobec

RESEARCH PROGRAMS

1. Telecommunication Systems
Prof. Gorazd Kandus
2. Parallel and Distributed Systems
Prof. Roman Trobec

R&D GRANTS AND CONTRACTS

1. Learning, Analysis, and Detection of Motion in the Framework of a Hierarchical Compositional Visual Architecture
Prof. Roman Trobec
2. Model for Domain-Specific Trend Prediction based on Semantic Enrichment of Unstructured Patterns
Prof. Roman Trobec
3. Advanced Procedures for Interactive Composition of Sensor Networks
Asst. Prof. Mihael Mohorčič
4. Open Communication Platform for Service Integration: CC OPCOMM
Asst. Prof. Mihael Mohorčič
5. Cloud Assisted Services: CC CLASS
Prof. Roman Trobec
6. Efficient Self-Configuration Methods for Wireless Mesh Networks
Dr. Carolina Fortuna

NEW CONTRACTS

1. Technologies for Next-Generation Intelligent Motorhome
Adria Mobil, d. o. o., Novo Mesto
Asst. Prof. Mihael Mohorčič

2. Propagation and Topology Design Evaluation for Wireless Sensor Networks Operating in License Exempt Frequency Bands
Cosylab, d. d.
Asst. Prof. Mihael Mohorčič

VISITORS FROM ABROAD

1. Prof. Luiz DaSilva, Department of Electronic and Electrical Engineering, Trinity College Dublin, Dublin, Ireland, 27.-30. 3. 2013
2. Camelia Marie Sarosi, Andrei Toma, Ciprian Anton, Technical University of Cluj-Napoca, Faculty for Electronics, Cluj-Napoca, Romania, 1.-15. 9. 2013
3. Prof. Veljko Milutinović, Faculty of Electrical Engineering, University of Beograd, Belgrade, Serbia, 8.-12. 7. 2013
4. Prof. Erich Leitgeb, Institut für Hochfrequenztechnik Graz, University of Technology, Graz, Austria, December 2013
5. Prof. Milica Pejanović Djurišić, Ministry of Defense Montenegro, Podgorica, Montenegro, 19.-23. 12. 2013
6. Prof. Zoran Veljović, prof. Igor Radušinović, Faculty of Electrical Engineering, University of Montenegro, Podgorica, Montenegro, 19.-23. 12. 2013
7. Prof. Karolj Skala, Instituta Ruder Bošković, Zagreb, Croatia, 16. and 24. 12. 2013

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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Iosif Androulidakis, Gorazd Kandus, "Mobile phone security - awareness and practices", *The journal of the Institute of Telecommunications Professionals*, vol. 7, no. 1, pp. 16-22, 2013.
2. Matija Cankar, Matej Artač, Marjan Šterk, Uroš Lotrič, Boštjan Slivnik, "Co-allocation with collective requests in grid systems", *J. univers. comput. sci. (Online)*, vol. 19, no. 3, pp. 282-300, 2013.
3. Matjaž Depolli, Janez Konc, Kati Rozman, Roman Trobec, Dušanka Janežič, "Exact parallel maximum clique algorithm for general and protein graphs", *J. chem. inf. mod.*, vol. 53, iss. 9, pp. 2217-2228, Sep. 2013.
4. Matjaž Depolli, Roman Trobec, Bogdan Filipič, "Asynchronous master-slave parallelization of differential evolution for multiobjective optimization", *Evol. comput.*, vol. 21, no. 2, pp. 261-291, 2013.
5. Michael J. Flynn, Oscar Mencer, Veljko Milutinović, Goran Rakočević, Per Stenstrom, Roman Trobec, Mateo Valero, "Moving from petaflops to petadata", *Commun. ACM*, vol. 56, no. 5, pp. 39-42, 2013.
6. Andrej Hrovat, Tomaž Javornik, "Analysis of radio propagation models for smart city applications", *Int. j. commun.*, vol. 7, no. 4, pp. 83-92, 2013.
7. Monika Kapus-Kolar, "Error-preserving local transformations on communication protocols", *Softw. test. verif. reliab.*, vol. 23, no. 1, pp. 3-25, 2013.
8. Monika Kapus-Kolar, "On the use of status messages in checking sequences for the distributed test architecture", *Elektrotehniški vestnik*, vol. 80, no. 5, pp. 240-244, 2013.
9. Gregor Kosec, Božidar Šarler, "Solution of a low Prandtl number natural convection benchmark by a local meshless method", In: Second International Conference on Computational Methods for Thermal Problems (ThermaComp 2011), Dalian, China, September 5-7, 2011, *Int. J. Numer. Methods Heat Fluid Flow*, vol. 23, no. 1, pp. 189-204, 2013.
10. Gregor Kosec, Peter Zinterhof, "Local strong form meshless method on multiple Graphics Processing Units", *Comput. model. eng. sci.*, vol. 91, no. 5, pp. 377-396, 2013.
11. Marko Kuder, Marjan Šterk, Borut Žalik, "Point-based rendering optimization with textured meshes for fast LiDAR visualization", *Comput. geosci.*, vol. 59, pp. 181-190, sep. 2013.
12. Erik Pertovt, Kemal Alič, Aleš Švigelj, Mihael Mohorčič, "Voice over internet protocol in wireless mesh networks with opportunistic network coding", *Int. j. commun.*, vol. 7, no. 2, pp. 42-53, 2013.
13. Aleš Švigelj, Mihael Mohorčič, Laurent Franck, Gorazd Kandus, "Signalling analysis for traffic class dependent routing in packet switched ISL networks", *Space commun.*, vol. 22, no. 2/4, pp. 191-203, 2013.
14. Ivan Tomašič, Sabina Frljak, Roman Trobec, "Estimating the universal positions of wireless body electrodes for measuring cardiac electrical activity", *IEEE trans. biomed. eng.*, vol. 60, iss. 12, pp. 3368-3374, 2013.
15. Ivan Tomašič, Aleksandra Rashkovska, Matjaž Depolli, Roman Trobec, "A comparison of hadoop tools for analyzing tabular data", *Informatica (Ljublj.)*, vol. 37, no. 1, pp. 131-138, 2013.
16. Alexey Volkov, Jerneja Žganec Gros, Mario Žganec, Tomaž Javornik, Aleš Švigelj, "Modulated acquisition of spatial distortion maps", *Sensors*, vol. 13, no. 8, pp. 11069-11084, 2013.

SHORT ARTICLE

1. Viktor Avbelj, Roman Trobec, "A closer look at electrocardiographic P waves before and during spontaneous cardioinhibitory syncope: letter to the editor", *Int. j. cardiol.*, vol. 166, no. 3, pp. e59-e61, 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

1. Mihael Mohorčič, "Integration of terrestrial and airborne wireless networks for emergency situations: the ABSOLUTE project", In: *Telekomunikacijski sistemi u vanrednim situacijama*, IX. međunarodni simpozij iz informacijsko-komunikacijskih tehnologija, INTSIKT 2013, 3-4 juna, 2013, Tuzla, [S. l., s. n.], 2013, 6 pp.

PUBLISHED CONFERENCE CONTRIBUTION

1. Adnan Bekan, Carolina Fortuna, Matevž Vučnik, Mihael Mohorčič, "Sensor as a service using the VESNA sensor platform", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference*, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 108-115.
2. Klemen Bregar, Viktor Avbelj, "Multi-functional wireless body sensor analysis of autonomy", In: *MIPRO 2013: Mipro proceedings*, (MIPRO ... (CD-ROM)), MIPRO 2013, 36th International Convention, May 20-24, 2013, Opatija, Croatia, Petar Biljanović, ed., Rijeka, Croatian Society for Information and Communication Technology, Electronics and Microelectronics, cop. 2013, pp. 346-349.
3. Hanwen Cao, Wei Jiang, Tomaž Javornik, Michael Wiemeler, Trung Thanh Nguyen, Thomas Kaiser, "Spectrum awareness scheme of the rapidly deployable eNodeB for unexpected and temporary events", In: *IEEE CAMAD 2013*, 18th International Workshop on Computer Aided Modeling and Design of Communication Links and Networks, 25-27 September 2013, Berlin, Germany, Danvers, IEEE, 2013, 6 pp.
4. Matjaž Depolli, Gregor Kosec, Janez Ugovšek, Vlado Malačič, "Parallelization of NAPOM implementation", In: *MIPRO 2013: Mipro proceedings*, (MIPRO ... (CD-ROM)), MIPRO 2013, 36th International Convention, May 20-24, 2013, Opatija, Croatia, Petar Biljanović, ed., Rijeka, Croatian Society for Information and Communication Technology, Electronics and Microelectronics, cop. 2013, pp. 223-227.
5. Andrej Hrovat, Tomaž Javornik, "Radio channel models for wireless sensor networks in smart city applications", In: *Recent advances in electronics, signal processing and communication systems: proceedings of the 2013 International Conference on Electronics, Signal Processing and Communication Systems, EPSCO 2013, September 28-30, 2013, Venice, Italy*, (Recent advances in electrical engineering series, 25), Charles A. Long, ed., Valeri Mladenov, ed., Klimis Ntalianis, ed., [S. l., s. n.], 2013, 8 pp.
6. Andrej Hrovat, Andrej Vilhar, Igor Ozimek, Tomaž Javornik, Enis Kocan, "GRASS-RaPlaT Radio Planning Tool for GRASS GIS system", In: *Conference proceedings, ICECom 2013, 21st International Conference on Applied Electromagnetics and Communications*, 14-16 October 2013, Dubrovnik, Croatia, Davor Bonefačić, ed., Zvonimir Šipuš, ed., Zagreb, KoREMA = Croatian Society for Communications, Computing, Electronics, Measurement and Control, 2013, 5 pp.
7. Melisa Junuzović, Carolina Fortuna, Adnan Bekan, Mihael Mohorčič, "Mesh network over the Rime stack using VESNA platforms", In: *Zbornik dvaindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2013, 16.-18. september 2013, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2013, zv. A, pp. 57-60.
8. Venceslav Kafedziski, Tomaž Javornik, "Frequency-space Interference alignment in multi-cell MIMO OFDM downlink systems", In: *VTC2013-Spring, WiVeC 2013*, 2013 IEEE 77th Vehicular Technology Conference and 5h International Symposium on Wireless Vehicular Communications, WiVeC, 2-5 June 2013, Dresden, Germany, Piscataway, IEEE, 2013, 5 pp.
9. Enis Kocan, Milica Pejanović-Djurišić, Tomaž Javornik, "BER performance enhancement in OFDM AF fixed gain relay system", In: *EUROCON 2013: Zagreb, Croatia, 1-4 July 2013*, Igor Kuzle, ed., Tomislav Capuder, ed., Hrvoje Pandžić, ed., Piscataway, IEEE, cop. 2013, pp. 502-507.
10. Gregor Kosec, Roman Trobec, "Parallel meshless simulation of a P-N junction", In: *Proceedings of the Fourteenth International Conference on Civil, Structural and Environmental Engineering Computing, 3-6 September 2013, Cagliari, Sardinia, Italy*, (Civil-comp proceedings, 102), Barry H. V. Topping, ed., Peter Iványi, ed., Stirlingshire, Civil-Comp Press, cop. 2013, 11 pp.
11. Mihael Mohorčič, Miha Smolnikar, Tomaž Javornik, "Wireless sensor network based infrastructure for experimentally driven research", In: *ISWCS'13, The Tenth International Symposium on Wireless Communication Systems*, 27-30 August 2013, Ilmenau, Germany, [S. l., s. n.], 2013, 5 pp.
12. Janez Ivan Pavlič, "Coarse grain molecular dynamics study of voids present in the membrane of a lipid vesicle", In: *MIPRO 2013: Mipro proceedings*, (MIPRO ... (CD-ROM)), MIPRO 2013, 36th International Convention, May 20-24, 2013, Opatija, Croatia, Petar Biljanović, ed., Rijeka, Croatian Society for Information and Communication Technology, Electronics and Microelectronics, cop. 2013, pp. 359-363.
13. Erik Pertovt, Kemal Alič, Aleš Švigelj, Mihael Mohorčič, "Analysis of the basic topology structure for neighbourhood network coding aware routing", In: *Zbornik dvaindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2013, 16.-18. september 2013, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2013, zv. A, pp. 37-40.
14. Erik Pertovt, Kemal Alič, Aleš Švigelj, Mihael Mohorčič, "Implementation and performance evaluation of ant-based control routing in wireless mesh networks using OPNET modeler", In: *OPNETWORK 2013: August 26-29, 2013, Washington, USA*, [S. l.], OPNET = Application and Network Performance, 2013, 7 pp.
15. Erik Pertovt, Kemal Alič, Aleš Švigelj, Mihael Mohorčič, "Network coding aware routing for performance boost in wireless-mesh-network", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference*, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 168-173.
16. Erik Pertovt, Kemal Alič, Aleš Švigelj, Mihael Mohorčič, "Performance evaluation of VoIP codecs over network coding in wireless mesh networks", In: *Recent advances in electronics and communication systems: proceedings of the 2013 International Conference on Electronics and Communication Systems, (ECS 2013), July 16-19, 2013, Rhodes Island, Greece*, (Recent advances in electrical engineering series, 15), Charles A. Long, ed., Nikos E. Mastorakis, ed., Valeri Mladenov, ed., [S. l., s. n.], 2013, pp. 43-49.
17. Toni Petrovič, Matjaž Vencelj, Matej Lipoglavšek, Roman Novak, Deniz Savran, "Pile-up reconstruction algorithm for high count rate gamma-ray spectrometry", In: *Proceedings of the International Conference on Recent Trends in Nuclear Physics, ICRNP 2012, 19-21 November, Barotiwala, India*, (AIP conference proceedings, vol. 1524, 2013), Sushil Kumar, ed., Ashok K. Jain, ed., New York, American Institute of Physics, 2013, vol. 1524, pp. 279-282, 2013.
18. Aleksandra Rashkovska, Viktor Avbelj, "Signal processing methods for ST variability assessment in ECG", In: *MIPRO 2013: Mipro proceedings*, (MIPRO ... (CD-ROM)), MIPRO 2013, 36th International Convention, May 20-24, 2013, Opatija, Croatia, Petar Biljanović, ed., Rijeka, Croatian Society for Information and Communication Technology, Electronics and Microelectronics, cop. 2013, pp. 355-358.
19. Tomaž Šolc, "SNE-ISMTV: VESNA wireless sensor node expansion for cognitive radio experiments", In: *ISWCS'13, The Tenth International Symposium on Wireless Communication Systems*, 27-30 August 2013, Ilmenau, Germany, [S. l., s. n.], 2013, 2 pp.
20. Tomaž Šolc, Zoltan Padrah, "Network design for the LOG-a-TEC outdoor testbed", In: *MERMAT 2013*, 2nd International Workshop on Measurement-based Experimental Research, Methodology and Tools, May 7th, 2013, Dublin, Ireland, [S. l., s. n.], 2013, 5 pp.
21. Ivan Tomašič, Aleksandra Rashkovska, Matjaž Depolli, "Using hadoop MapReduce in a multicluster environment", In: *MIPRO 2013: Mipro proceedings*, (MIPRO ... (CD-ROM)), MIPRO 2013, 36th International Convention, May 20-24, 2013, Opatija, Croatia, Petar Biljanović, ed., Rijeka, Croatian Society for Information and Communication Technology, Electronics and Microelectronics, cop. 2013, pp. 369-374.
22. Ivan Tomašič, Roman Trobec, Ratko Magjarević, "Principal component analysis of differential electrocardiographic leads - leads a Contribution to the synthesis of ECGs", In: *The International Conference on Health Informatics: Ichi 2013, Vilamoura, Portugal on 7-9 November, 2013*, (IFMBE Proceedings, 42), Igor Lacković, ed., Cham [etc.], Springer, 2013, pp. 260-263.
23. Roman Trobec, Iztok Belehar, Janez Polajnar, Matjaž Veselko, "Ski injury triggers of tibial plateau compression fracture", In: *MIPRO 2013: Mipro proceedings*, (MIPRO ... (CD-ROM)), MIPRO 2013, 36th International Convention, May 20-24, 2013, Opatija, Croatia, Petar Biljanović, ed., Rijeka, Croatian Society for Information and Communication Technology, Electronics and Microelectronics, cop. 2013, pp. 384-388.

24. Roman Trobec, Matjaž Depolli, Karolj Skala, T. Lipić, "Energy efficiency in large-scale distributed computing systems", In: *MIPRO 2013: Mipro proceedings*, (MIPRO ... (CD-ROM)), MIPRO 2013, 36th International Convention, May 20-24, 2013, Opatija, Croatia, Petar Biljanović, ed., Rijeka, Croatian Society for Information and Communication Technology, Electronics and Microelectronics, cop. 2013, pp. 273-277.
25. Alvaro Valcarce, Tinku Rasheed, Karina Gomez, Sithamparanathan Kandeepan, Laurent Reynaud, Romain Hermenier, Andrea Munari, Mihael Mohorčič, Miha Smolnikar, Isabelle Bucaille, "Airborne base stations for emergency and temporary events", In: *PSATS 2013*, 5th International Conference on Personal Satellite Services, June 27-28, 2013, Toulouse, France, [S. l., s. n.], 2013, 12 pp..
26. Andrej Vilhar, Andrej Hrovat, Tomaž Javornik, Mihael Mohorčič, "Experimental analysis of wireless temporary networks deployed by low altitude platforms", In: *IEEE CAMAD 2013*, 18th International Workshop on Computer Aided Modeling and Design of Communication Links and Networks, 25-27 September 2013, Berlin, Germany, Danvers, IEEE, 2013, 6 pp.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. H. P. Hinov, Janez Ivan Pavlič, L. Todorova, Y. G. Marinov, S. Sridevi, M. Slaveikova, A Petrov, P. M. Rafailov, U. Dettlaff-Weglikowska, "Influence of carbon nanotubes and a phospholipid surface layer on the electro-optic behavior of a homeotropic E7", In: *New developments in liquid crystals and applications*, (Materials science and technologies), P. K. Choudhury, ed., New York, Nova Science, 2013, pp. 151-197.
2. Klemen Kenda, Carolina Fortuna, Alexandra Moraru, Dunja Mladenčič, Blaž Fortuna, Marko Grobelnik, "Mashups for the web of things", In: *Semantic mashups: intelligent reuse of web resources*, Brigitte Endres-Niggemeyer, ed., Berlin, Heidelberg, Springer, 2013, pp. 145-169.

PATENT APPLICATION

1. Aleksandra Rashkovska, Roman Trobec, *Postopek in naprava za neinvazivno vodenje notranjih temperaturnih spremenljivk v realnem času med terapijo z ohlajanjem ali ogrevanjem*, P-201300113, Urad RS za intelektualno lastnino, 8.3.2013..

PATENT

1. Bojan Likar, Robert Posel, Andreas Kalagasidis, Tomaž Javornik, Gorazd Kandus, Mihael Mohorčič, Aleš Švigelj, Janez Bešter, Andrej Kos, Miha Smolnikar, *Iterative localization techniques*, US8565106 (B2), US Patent Office, 22.10.2013.
2. Bojan Likar, Robert Posel, Andreas Kalagasidis, Tomaž Javornik, Gorazd Kandus, Janez Sterle, Urban Sedlar, Janez Bešter, Andrej Kos, Luka Mali, *Method for self organizing network operation*, US8472334 (B2), US Patent Office, 25.6.2013.

MENTORING

1. Carolina Fortuna, *Dynamic composition of communication services*: doctoral dissertation, Ljubljana, 2013 (mentor Mihael Mohorčič; co-mentor Dunja Mladenčič).
2. Amir Ligata, *Radio frequency impairments in cooperative broadband wireless communication systems*: doctoral dissertation, Ljubljana, 2013 (mentor Tomaž Javornik; co-mentor Haris Gačanin).
3. Aleksandra Rashkovska, *Real-time control of hidden system variables with application in therapeutic knee cooling*: doctoral dissertation, Ljubljana, 2013 (mentor Roman Trobec).
4. Ivan Tomašič, *Personalized synthesis of the 12-lead ECG from bipolar leads*: doctoral dissertation, Zagreb, 2013 (mentors Ratko Magjarević, Roman Trobec).

COMPUTER SYSTEMS DEPARTMENT

E-7

The Computer Systems department is concerned primarily with the development of advanced computing structures and efficient algorithms for massive-data processing, and systems for effective human-computer interaction. Within this broad area, we are concentrating on self-reparable and self-organizing systems, modeling and optimizing of complex, dynamic and nondeterministic systems. Our research results are implemented within applications for production, transport, energy, environmental sustainability, bioinformatics, health, and medicine. As an integral part of our research activities, members of the department have close contacts and collaborations with scientists world-wide, through academic links and industrial contacts, thus enabling us to keep at the forefront of rapidly developing fields.

Advanced computer structures for data processing

In the field of the advanced computer structures we were developing a system for the processing of massive data. Within the application project *Processing of massive geometric LIDAR data* we developed a hardware accelerator for the compression of LIDAR data. For this purpose, hardware predictors of the point coordinates and other attributes of LIDAR data were developed. The predictors of the point coordinates consist of two methods: linear prediction using last-coordinate changes, and the search for the closest coordinate change among the most recent coordinate changes. The applied method is dynamically selected based on the resemblance of the current search result. A pipelined hardware divider, required for linear prediction, was also developed. An adjustable pipeline depth enabled us to select the most suitable divider with respect to the dividers' latency, the usage of the hardware resources, and the clock period. The coordinate prediction and the prediction of other LIDAR data attributes are used in the prediction compression of the LIDAR data. Additionally, a variable length encoder was developed, and the arithmetic coder was improved by using the barrel-shifter structure, which resulted in an up to 8-times higher data throughput. Modules were developed in the VHDL language and verified in the Cadence simulation environment. Individual modules were synthesized and tested on the Xilinx XUPV5 prototype board.

We continue the development of self-reparable systems based on FPGA. The SRAM-based field-programmable gate arrays (FPGAs) in mission-critical systems require error mitigation and recovery techniques to protect them from the errors caused by high-energy radiation, also known as single-event upsets (SEUs). We developed a SEU-recovery mechanism with a smaller hardware overhead than the existing solutions. According to the required levels of reliability, different architectures of the self-recoverable mechanism can be employed. The efficiency of the proposed approach was evaluated with a specially developed fault-emulation environment. In contrast to conventional fault-injection methods based on radiation techniques, the developed fault emulation enables the user to inject faults at selected locations of the configuration memory. Individual parts of the recovery infrastructure can be analyzed using a developed fault-emulation environment. In this way, modifications and possible improvements to the recovery infrastructure can be easily and precisely evaluated. The resulting estimated reliability of our error-recovery mechanism is superior to other reported solutions.

We developed electronic circuits with advanced functionalities. In collaboration with BSH Hišni aparati, d.o.o., Nazarje, we upgraded the electronic circuits in their household appliances MUM5 and MUMXL. We added electronic circuits to their appliances to implement some additional functionalities, and improve their usability. The developed microcontroller and additional sensors allow the remote monitoring and control of the appliances, while still allowing unchanged functionalities of the original appliances.



Head:
Prof. Franc Novak

We developed an e-service and a mobile application “eDietetik” (<http://www.edietetik.si/>) for patients with special nutritional needs (coeliac disease, diabetes, phenylketonuria and hypertension).

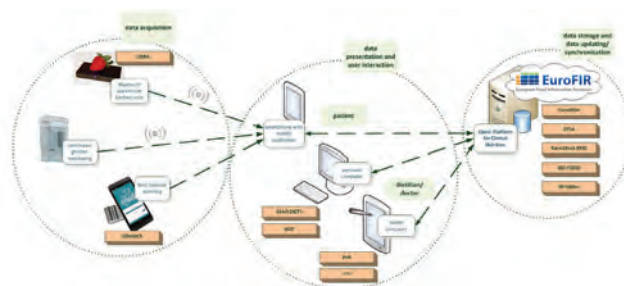


Figure 1: Open Platform for Clinical Nutrition in the context of various domestic and international eHealth projects

Efficient algorithms for computer data-processing

Research in the field of the development of efficient algorithms for computer data processing was focused in the development of computer support for diet planning. We developed an e-service and a mobile application *eDietetik* (<http://www.edietetik.si/>) for patients with special nutritional needs (coeliac disease, diabetes, phenylketonuria and hypertension). The e-service and the application provide, through the food barcode scanning, immediate informing for a user about the composition of the food. In connection with the existing web application *Open Platform for Clinical Nutrition - OPEN* (<http://www.opkp.si/>), *eDietetik* allows the creation of optimal diet menus with the use of a multi-criteria approach. Within the project *DIETS2* (<http://www.thematicnetworkdietetics.eu/everyone/>) we translated the user interface of the OPEN into English and an additional McCance and Widdowson's food composition database was added to the OPEN dataset, to be used by the European Federation of the Association of Dietitians (EFAD).

Within the FP7 European project *EuroFIR NEXUS* (<http://www.eurofir.org/>) we setup the computer infrastructure (standards, protocols and web services) for the interchange of data of food composition databases between research institutions and the private sector. OPEN is a part of this infrastructure and allows the interchange of Slovenian food composition data with other research centers in Europe. It is regarded as a national information point. In this context we collaborated with the National Institute for Public Health (NIJZ) when creating the national nutritional profile.

In the FP7 European project *EuroDISH* (<http://www.eurodish.eu/>) we designed and implemented an algorithm for the semi-automated matching of food consumption and food composition data from various national food databases. By using the algorithm, knowledge from different food data and information sources can be linked, which is particularly important in addressing the issue of food safety. We applied our knowledge from the field of stochastic optimization. The developed algorithm is an important part of the methodology for collecting and analyzing food consumption data, which we develop in collaboration with NIJZ RS. To support this methodology we have upgraded the OPKP platform with a 24h-recall method for collecting and statistically analyzing food-consumption data.

We organized the annual meeting and the conference EuroFIR Nexus *Developments in Food Composition Information Systems supporting ethnic and traditional food in Europe* in Ljubljana. The subject of the conference was the problem of ethical and traditional food from the compositional and informational point of view. We hosted about 100 delegates from 50 European organizations. Within the conference we also organized the *Workshop of EuroFIR/EuroDISH on Food Matching*, where the delegates from several European research centers discussed the problem of food data matching from the computer-support point of view.

In the field of self-organizing systems we worked on the parameter-less and self-adaptive control of the optimization algorithms. The effectiveness of the approach, where the user does not need any specific knowledge on control parameter setting, was tested in the context of multi-criteria optimization. The highest usability of the approach is seen in connection with self-organizing emergent systems. For this reason, we study stigmergy, i.e., coordination, where the collective functioning of the system is achieved by indirect interactions between elements of the system. We investigate both sematectonic, as well as sign-based stigmergy. Sematectonic stigmergy denotes communication via the modification of a physical environment, while sign-based stigmergy denotes communication via a signaling mechanism.

The principle of self-organizing stigmergic systems is used in the implementation of the solutions for optimization procedures within the ARTEMIS project *Adaptive Cooperative Control in Urban (sub) Systems - ACCUS* (<http://www.projectaccus.eu/>), where we develop the platform for the integration and coordination of urban systems (transportation, outdoor lighting, energy) to build applications across urban systems, to provide adaptive and cooperative control for urban subsystems, and to optimize the combined performance.

In cooperation with the Department of Intelligent Systems and the Laboratories for Computer Architecture and Languages and Programming Methodologies from the Faculty of Electrical Engineering and Computer Science, University of Maribor, we organized, for the tenth consecutive year, the workshops on *Nature-inspired algorithms* about stochastic optimization techniques.

We introduced a new social network model that takes into consideration the balance theory and stigmergy as a way of interaction between individuals.



Figure 2: The MUMXL food mixer with upgraded electronics

We developed a website-usability testing tool.

Human-computer interaction

In the area of human-computer interaction we developed in collaboration with the Faculty of Electrical Engineering and Computer Science, University of Maribor, a website-usability testing tool. The tool can be used for the analysis of visual usability of a website design from the perspective of user cognitive load.

We also participate in an informal community of *Slovenian human-computer interaction researchers* (<http://hci.si/>) initiated by the Faculty of Computer and Information Science, University of Ljubljana, XLAB Research, Ljubljana, and the Jožef Stefan Institute. In the frame of the 16th international Information Society – IS 2013 multiconference we organized the conference Human-computer Interaction in Information Society. On this occasion we presented the mobile application *eDietetik* for the presentation of health-related information.

In the network modeling studies we discussed three aspects of large graphs. The first aspect represents the network measures and indices that serve as the presentation of the structural graph properties. In this context the focus is given to the Wiener index and the problem of specifying graph families for which the Wiener index equals the Wiener index of its line graph. Additionally, two new centrality indices are introduced, their extreme values are proven and the structures of graphs where these values are achieved are determined. Another aspect relates to the modeling of the social network. It introduced a new social network model, which takes into consideration the balance theory and stigmergy as a way of interaction between individuals. For the evaluation and validation of the model various model characteristics are calculated and analyzed and they are compared to the characteristics of real networks. The last aspect refers to the robustness of the hypercube, which is a frequent topology of parallel networks. We proved that the given upper bound of mutually-independent s -starting Hamiltonian cycles in the hypercube with faulty edges is tight. These three aspects are presented in depth in the PhD thesis *Large graphs in advanced applications*.

In the process of building the methodological framework for analytics technology integration in organizations we addressed the problems and challenges faced by analytics practitioners in the initial stages of technology integration, where its success influences the later phases of integration. The findings may be applied in various analytics domains, i.e., data-mining, forecasting/extrapolation, modeling, simulation, and optimization. To increase the efficiency of the initial analytics we proposed a methodological framework – a system of principles, practices, and procedures. For the data-mining (DM) case, the methodological framework was validated and reported through a series of case studies. Our findings indicate a significant range of considerations and reveal additional issues for applied decision making in the context of DM requirements and process success. Best practices of embryonic DM are expressed by seven success factors and four success measures. Moreover, a process model for carrying out embryonic DM was designed. The methodological framework building and the corresponding research process are presented in the PhD thesis *A Methodological Framework for Integration Of Data Mining in Organizations*.

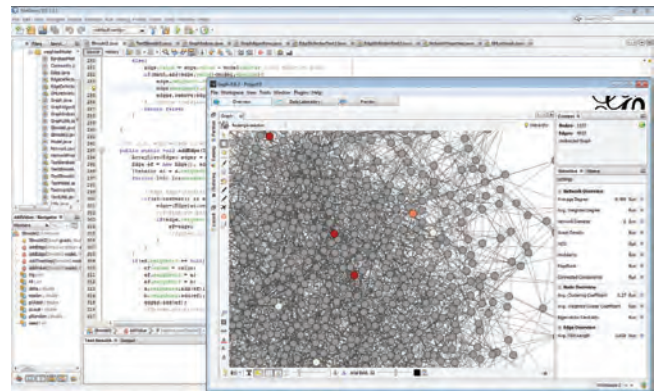


Figure 3: The social networks modeling

Some outstanding publications in the past year

1. Papa, G.: Parameter-less algorithm for evolutionary-based optimization: for continuous and combinatorial problems, *Computational Optimization and Applications*, 56 (2013) 1, 209–229
2. Korošec, P., Šilc, J.: The continuous differential ant-stigmergy algorithm for numerical optimization, *Computational Optimization and Applications*, vol. 56 (2013) 2, 481–502
3. Biasizzo, A., Novak, F.: Hardware accelerated compression of LIDAR data using FPGA devices, *Sensors*, 13 (2013) 5, 6405–6422
4. Korošec, P., Bole, U., Papa, G.: A multi-objective approach to the application of real-world production scheduling, *Expert Systems with Applications*, 40 (2013) 15, 5839–5853
5. Korošec, P., Papa, G.: Metaheuristic approach to transportation scheduling in emergency situations, *Transport*, 28 (2013) 1, 46–59

Organization of conferences, congresses and meetings

1. Second Annual Meeting and Conference of EuroFIR Nexus “Developments in Food Composition Information Systems supporting ethnic and traditional food in Europe”, Ljubljana, Slovenia, 5.–7. 3. 2013
2. Workshop of EuroFIR/EuroDISH “Food Matching”, Ljubljana, Slovenia, 8. 3. 2013
3. AVN, The 22nd Workshop Nature-Inspired Algorithms, Šmarna Gora, Slovenia, 21. 5. 2013

4. HCI – IS, Human-Computer Interaction in Information Society, part of the 16th Information Society Multi-conference, Ljubljana, Slovenia, 8. 10. 2013
5. AVN, The 23rd Workshop Nature-Inspired Algorithms, Maribor, Slovenia, 16. 12. 2013

INTERNATIONAL PROJECTS

1. 7FP - EuroFIR-Nexus; The EuroFIR Food Platform: Further Integration, Refinement and Exploitation of for its Long-term
European Commission
Asst. Prof. Barbara Koroušič Seljak
2. COST IC1204; Trustworthy Manufacturing and Utilization of Secure Devices
COST Office
Prof. Franc Novak
3. HiPEAC; European Network of Excellence on High Performance and Embedded Architecture and Compilation
Ghent University
Prof. Franc Novak
4. EuroFIR AISBL Infrastructure Consultancy
EuroFIR AISBL
Prof. Peter Korošec
5. Upgrade of the Open Platform for Clinical Nutrition to Suit the Needs of the Federation of EU Member National Associations of Dietitians EFAD
EuroFIR AISBL
Asst. Prof. Barbara Koroušič Seljak
6. EuroDISH; EuroDISH Determinants-Intake-Status-Health
European Commission
Asst. Prof. Barbara Koroušič Seljak

R&D GRANTS AND CONTRACTS

1. Processing of Massive Geometric LIDAR Data
Prof. Franc Novak
2. eDietitian: Mobile Diet Guide
Asst. Prof. Barbara Koroušič Seljak
3. Adaptive Cooperative Control in Urban (Sub)Systems
Asst. Prof. Gregor Papa

NEW CONTRACTS

1. Analysis of Possible Upgrades of the A-Portal Web Platform
Abak.net, d. o. o.
Asst. Prof. Gregor Papa
2. Study of the Effects of Upgrading on ISL Online Software
Xlab, d. o. o.
Asst. Prof. Gregor Papa
3. Energy Efficiency Improvement Study of the Blue Tracker Tracking Device
Ema, d. o. o.
Prof. Franc Novak

RESEARCH PROGRAM

1. Computer Structures and Systems
Prof. Stanislav Kovačič

VISITORS FROM ABROAD

1. Prof. Mirjana Gurinović, Prof. Marija Glibetič, Dr. Agnes Kadvan, Jelena Milešević, Ph. D. student, Dr. Snježana Petrovič, Slavica Ranković, Ph.D. student, Institute for Medical Research, Belgrade, Serbia, 3.-6. 3. 2013
2. Heikki Pakkala, National Institute for Health and Welfare (THL), Finland, 4.-8. 3. 2013
3. Tue Christensen, Technical University of Denmark, Denmark, 8. 3. 2013
4. Aida Turrini, Istituto Nazionale di Ricerca per gli Alimenti e la Nutrizione (INRAN), Roma, Italy, 8. 3. 2013
5. Karl Presser, Premotec GmbH, Zurich, Switzerland, 8. 3. 2013
6. Sandra Crispim, Jan van der Laan, Institut national de la recherche agronomique (INRA), Paris, France, 8. 3. 2013

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2. Prof. Peter Korošec
3. Asst. Prof. Barbara Koroušič Seljak
4. Prof. Stanislav Kovačič*
5. **Prof. Franc Novak, Head**
6. Asst. Prof. Gregor Papa
7. Asst. Prof. Jurij Šilc

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8. Dr. Drago Torkar

9. Dr. Vida Vukašinović

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10. Lucas Benedičič**
11. Uroš Bole**

Technical and administrative staff

12. Jolanda Jakofčič

Note:

* part-time JSI member

** postgraduate financed by industry

BIBLIOGRAPHY

ORIGINAL ARTICLE

- Anton Biasizzo, "On-line testing and recovery of systems with dynamic partial reconfiguration", *Inf. MIDE*, vol. 43, no. 4, pp. 259-266, 2013.
- Anton Biasizzo, Franc Novak, "Hardware accelerated compression of LIDAR data using FPGA devices", *Sensors*, vol. 13, no. 5, pp. 6405-6422, 2013.
- Anton Biasizzo, Franc Novak, Peter Korošec, "A multi-alphabet arithmetic coding hardware implementation for small FPGA devices", *J. Elektr. Eng.*, vol. 64, no. 1, pp. 44-49, 2013.
- Mojca Bizjak, Zala Jenko Pražnikar, Barbara Koroušič-Seljak, "Development and validation of an electronic FFQ to assess food intake in the Slovene population", *Public health nutr. (Wallingford. Online)*, ilustr.
- Janez Brest, Peter Korošec, Jurij Šilc, Aleš Zamuda, Borko Bošković, Mirjam Sepesy Maučec, "Differential evolution and differential ant-stigmergy on dynamic optimisation problems", *Int. J. Syst. Sci.*, vol. 44, no. 4, pp. 663-679, 2013.
- Uroš Kač, Franc Novak, "Reconfiguration schemes Of SC biquad filters for oscillation based test", *Inf. technol. valdyn.*, vol. 42, no. 1, pp. 38-47, 2013.
- Mojca Korošec, Terezija Golob, Jasna Bertonec, Vekoslava Stibilj, Barbara Koroušič-Seljak, "The Slovenian food composition database", In: Food composition and sustainable diets, 9th International Food Data Conference, September 14-17, 2011, Norwich, United Kingdom, *Food Chem.*, vol. 140, no. 3, pp. 495-499, 2013.
- Peter Korošec, Uroš Bole, Gregor Papa, "A multi-objective approach to the application of real-world production scheduling", *Expert syst. appl.*, vol. 40, issue 15, pp. 5839-5853, 2013.
- Peter Korošec, Gregor Papa, "Metaheuristic approach to transportation scheduling in emergency situations", *Transport (Vilnius (Spausd.))*, vol. 28, no. 1, pp. 46-59, 2013.
- Peter Korošec, Jurij Šilc, "The continuous differential ant-stigmergy algorithm for numerical optimization", *Computat. optimiz. appl.*, vol. 56, no. 2, pp. 481-502, 2013.
- Peter Korošec, Marian Vajteršič, Jurij Šilc, Rade Kutil, "Multi-core implementation of the differential ant-stigmergy algorithm for numerical optimization", In: Proceedings of the 14th International Workshop on Nature Inspired Distributed Computing, NIDISC 2011 in conjunction with 25th IEEE/ACM International Parallel and Distributed Processing, IPDPS 2011, May 16-20, 2011 Anchorage, Alaska, USA, *J. Supercomput.*, vol. 63, no. 3, pp. 757-772, 2013.
- Barbara Koroušič-Seljak, Vekoslava Stibilj, Larisa Pograjc, Nataša Fidler Mis, Evgen Benedik, "Food composition databases for effective quality nutritional care", In: Food composition and sustainable diets, 9th International Food Data Conference, September 14-17, 2011, Norwich, United Kingdom, *Food Chem.*, vol. 140, no. 3, pp. 495-499, 2013.
- Rok Mandeljc, Stanislav Kovačič, Matej Kristan, Janez Perš, "Tracking by identification using computer vision and radio", *Sensors*, vol. 13, no. 1, pp. 241-273, Jan. 2013.
- Rok Mandeljc, Stanislav Kovačič, Matej Kristan, Janez Perš, "Non-sequential multi-view detection, localization and identification of people using multi-modal feature maps", In: Computer vision - ACCV 2012: revised selected papers. Part 3, *Lect. Notes Comput. Sci.*, vol. 7726, pp. 691-704, 2013.
- Boštjan Murovec, Janez Perš, Rok Mandeljc, Vildana Sulić Kenk, Stanislav Kovačič, "Towards commoditized smart-camera design", *J. systems archit.*, vol. 59, no. 10, part A, pp. 847-858, 2013.
- Peter Novak, Franc Novak, Barbara Koroušič-Seljak, "Enhancement of web application design of the open platform for clinical nutrition", In: Human factors in computing and informatics: proceedings, First International Conference, SouthCHI 2013, Maribor, Slovenia, July 1-3, 2013, *Lect. Notes Comput. Sci.*, vol. 7946, pp. 791-802, 2013.
- Gregor Papa, "Parameter-less algorithm for evolutionary-based optimization: for continuous and combinatorial problems", *Computat. optimiz. appl.*, vol. 56, issue 1, pp. 209-229, 2013.
- Janez Perš, Matej Kristan, Rok Mandeljc, Stanislav Kovačič, Aleš Leonardis, "Hierarhična kompozicionalna arhitektura za detekcijo in razpoznavanje aktivnosti", *Elektrotehniški vestnik*, vol. 80, no. 5, pp. 258-265, 2013.
- Mitja Placer, Stanislav Kovačič, "Enhancing indoor inertial pedestrian navigation using a shoe-worn marker", *Sensors*, vol. 13, no. 8, pp. 9836-9859, Aug. 2013.
- Nada Rotovnik-Kozjek, Živa Mrevlje, Barbara Koroušič-Seljak, Katja Kogovšek, Branko Zakotnik, Iztok Takač, Matjaž Horvat, Tadej Dovšak, Vojislav Didanovič, Andrej Kansky, Jožica Červek, Vaneja Velenik, Franc Anderluh, Milena Kerin-Povšič, Matjaž Sever, Primož Strojjan, Borut Štabuc, Mojca Unk, Jernej Benedik, Erik Breclj, Tadeja Pintar, Lidija Kompan, Marko Novak, Laura Petrica, Denis Mlakar-Mastnak, Brigita Avramović Brumen, Eva Peklaj, Rajmonda Jankovič, Urška Jelenko, Edita Rotner, Sanja Đukić, Petra Tavčar, "Kaheksija pri bolnikih z rakom", *Zdrav Vestn (Tisk. izd.)*, vol. 82, no. 3, pp. 133-141, mar. 2013.
- Vida Vukašinovič, Petr Gregor, Riste Škrekovski, "On the mutually independent Hamiltonian cycles in faulty hypercubes", *Inf. sci.*, vol. 236, pp. 224-235, jul. 2013.

PUBLISHED CONFERENCE CONTRIBUTION

- Anton Biasizzo, "On-line testing and recovery of systems with dynamic partial reconfiguration", In: *Proceedings*, 49th International Conference on Microelectronics, Devices and Materials & the Workshop on Digital Electronic Systems, September 25 - September 27, 2013, Kranjska Gora, Slovenia, Andrej Žemva, ed., Polona Šorli, ed., Iztok Šorli, ed., Ljubljana, MIDE - Society for Microelectronics, Electronic Components and Materials, 2013, pp. 13-19.
- Peter Korošec, Jurij Šilc, "The continuous differential ant-stigmergy algorithm applied on real-parameter single objective optimization problems", In: *IEEE Congress on Evolutionary Computation*, [2013 IEEE CEC], June 20-23, 2013, Cancun, Mexico, [S. l.], IEEE, cop. 2013, pp. 1658-1663.
- Barbara Koroušič-Seljak, "How to provide health-related information by mobile computing?", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 225-228.
- Franc Novak, Denis Špelič, Borut Žalik, "A website usability testing tool", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 217-220.
- Gregor Papa, Jurij Šilc, "The parameter-less evolutionary search for real-parameter single objective optimization", In: *IEEE Congress on Evolutionary Computation*, [2013 IEEE CEC], June 20-23, 2013, Cancun, Mexico, [S. l.], IEEE, cop. 2013, pp. 1131-1137.
- Miha Ristič, Franc Novak, "Towards improved emergency call service: a usability test case study", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 229-232.

MENTORING

- Uroš Bole, *A methodological framework for integration of data mining in organizations*: doctoral dissertation, Ljubljana, 2013 (mentor Gregor Papa).
- Vida Vukašinovič, *Large graphs in advanced applications*: doctoral dissertation, Ljubljana, 2013 (mentor Jurij Šilc; co-mentor Riste Škrekovski).

DEPARTMENT OF KNOWLEDGE TECHNOLOGIES

E-8

The Department of Knowledge Technologies performs research in advanced information technologies aimed at acquiring, storing and managing knowledge to be used in the development of knowledge-based applications. Established areas include intelligent data analysis (machine learning, data mining, and knowledge discovery in databases), semantic data mining and the semantic web, language technologies and computational linguistics, decision support and knowledge management. Apart from research in knowledge technologies, we are also developing applications in environmental sciences and ecology, medicine and health care, biomedicine and bioinformatics, economy and marketing.

In 2013 we were involved in six national and eleven FP7 projects, two COST actions, one network financed by the European Science Foundation, one infrastructure project and two industry projects.

In the area of intelligent data analysis and data mining we have developed several new methods and used them in a number of application domains. In collaboration with the University of Helsinki we have developed a new method for contrasting subgroup discovery and successfully applied it to the analysis of differential gene expression of virus-infected potato plants, aimed at improved understanding of the plants' response to virus attack. We developed a methodology for analyzing text-enriched heterogeneous information networks, which was successfully applied in the analysis of video lectures on the VideoLectures.net portal. The developed NoiseRank methodology for ensemble-based noise and outlier detection was applied to a medical problem domain and the detection of atypical newspaper articles. A new platform ViperCharts enables the visualization of noise-detection performance results as well as a visual evaluation of the quality of information-extraction algorithms. We developed a new propositionalization method, named wordification, for transforming relational data into bag-of-words vectors: the method, which was successfully applied to data in the IMDB film database, is made available within the ClowdFlows web platform, which supports data analysis in the cloud. The banded matrices methodology has been applied in a new task of cross-domain narrative ideation. We developed a new sentiment analysis methodology, which was successfully applied in a sentiment analysis of financial tweets. We improved the HCI interface of the CrossBee bisociation knowledge discovery system, which can be used for the analysis of scientific articles with the aim of discovering new links between different domains.

We continued our successful collaboration in the FP7 FET project MUSE (Machine Understanding for interactive Storytelling) in the area of the computer understanding of natural language, the goal of which is to convert text into its 3D animation. In October 2013 we started a collaboration in two new FP7 computational creativity projects, ConCreTe (Concept Creation Technologies) and WHIM (The What-If Machine), while continuing the collaboration in the FP7 coordination action PROSECCO, whose goal is the promotion of activities in the area of computational creativity.

We have developed new methods for learning decision trees and ensembles for structured output prediction (multi-target classification and regression and (hierarchical) multi-label classification), some of which can also take into account the spatial or network location of specific examples. New methods were used for searching and labeling images, modeling of dynamic systems and for different problems in the area of environmental sciences, such as the habitat modeling of various organisms and the modeling of gene flow between conventional and genetically modified crops. In the area of life sciences we have used the newly developed methods for identifying relations between health state and gut microbiota composition, and for gene-function prediction, where we have produced more than 400,000 reliable function predictions for genes from about a thousand bacterial genomes (the predictions are available on server <http://gorbi.irb.hr/>), and we have contributed to a comprehensive overview study of computational methods for gene-function prediction.



Head:
Prof. Nada Lavrač

Nada Lavrač received the Zois Recognition Award for her work in intelligent data analysis. The awards are given annually to Slovene scientists for important contributions to science, research and development.



Figure 1: In the FP7 project FIRST we developed systems for evaluating the reputation of financial institutions, the detection of financial manipulations, assistance in stock trading, and for monitoring of events connected to the current financial crisis.

We have further developed methods for learning models of dynamical systems from data and domain background knowledge and considered different methods and criteria for parameter optimization as well as ensembles of such models. This research was part of the F7P project SUMO (Supermodeling by combining imperfect models). These methods were also used for the modeling of aquatic ecosystems and the process of endocytosis, which is a key part of the immune system. In the FP7 project REWIRE (Rehabilitative Wayout In Responsive home Environments), which aims at the development of a rehabilitation system for post-stroke patients, we have applied methods for machine learning to analyze patient data together with data collected from wearable sensors. The aim was to monitor patient rehabilitation and to design an adaptive rehabilitation plan.

In the area of text and web mining and heterogeneous information network analysis we continued our research in the framework of four FP7 projects. FIRST (Large scale information extraction and integration infrastructure for supporting financial decision making) was successfully concluded in October 2013 with an excellent final evaluation. FOC (Forecasting Financial Crises) is about to be concluded in February 2014. We started work on two new

Marko Bohanec and co-authors received the Outstanding Paper Award at the 26th Bled eConference for their contribution "Hot stock or not? A qualitative multi-attribute model to detect financial market manipulation".

projects, SIMPOL (Financial Systems Simulation and Policy Modelling) and MULTIPLEX (Foundational Research on MULTilevel comPLEX networks and systems). We focused on analyzing large amounts of dynamic and heterogeneous sources of financial information and developed online data-mining tools for the near-real-time processing of vast amounts of constantly evolving data (financial news, blogs and tweets). We permanently monitored 200 financial websites, capturing about 40,000 documents per day. In 2013

we focused on data analysis and end-user solutions, such as a sentiment analysis on financial products, estimating the reputation of financial institutions, and on-online fraud detection. In FOC we extracted indicators based on the sentiment analysis of large streams of textual data, with the goal of forecasting financial crises. The SIMPOL project is intended as a support for decision makers and regulators in policy modeling and impact analysis, with the emphasis on climate finance and regulations. The main goal of MULTIPLEX is oriented towards the use of the mathematical framework of Complex Networks and Algorithmics to establish a theoretical basis for the understanding, prediction and, possibly, the control of Complex Systems.

During the parliamentary elections in Bulgaria, in May 2013, we launched a public-sentiment monitoring solution in collaboration with Gama System. We developed a sentiment analysis system that collected and analyzed tweets about the major political parties. The sentiment charts were shown in real time on a web portal, before and during the elections. It turns out that the cumulative sentiment (the difference between the number of positive and negative tweets) very accurately reflects the actual elections results. The parties that won the highest number of

parliamentary seats had the highest cumulative sentiment, albeit with the inverted sign (i.e., a party with the highest number of negative tweets won the highest number of seats in the newly elected parliament).

In the area of language technologies we concluded with the compilation of language resources of historical Slovene, which contain a digital library of older Slovene literature with facsimiles and hand-corrected and marked-up transcriptions (over 600 books, 45,000 pages), a hand-annotated corpus with modernized word-forms and other linguistic mark-up (300,000 tokens, 1,100 pages) and a lexicon giving glosses for archaic words (20,000 entries, 70,000 word-forms). All the resources are encoded using the TEI P5 Guidelines and available on the Web for reading and searching, as well as for download in the source XML format under the CC-BY license. These resources are already used for teaching the history of Slovene language and literature at several university departments and secondary schools. On the basis of the produced resources we developed a method for modernizing old words, which uses statistical machine translation, although not on words but characters. In the context of our research on the normalization of non-standard language we also studied the behavior of Slovene clitics in older texts and made a preliminary analysis of the differences between the language of tweets and standard Slovene.

After the completion of the project "Slovene translation studies - resources and research" we summarized our work on the linguistic annotation of parallel bi-lingual corpora in the textbook published in the scope of the project. The project "Communication in Slovene", which compiled a new generation of Slovene reference corpora, also ended in 2013. We mounted the corpora of the project, as well as all the others that our department helped to compile, under the high-performance noSketchEngine concordancer and the CUWI concordancer, developed by us. Linguists from Slovenia and abroad are now able to use advanced analytical techniques on over 30 different

Taxonomy ID	Taxonomy name	Gene name	ENTREZ Gene ID	UniProt ID	GO ID	GO name	GOBI precision
272363	Clonidium difficile 630	CD3339	4932957	Q181D6	GO:0006308	rRNA metabolic process	1
272363	Clonidium difficile 630	CD2962	4815815	Q14227	GO:0006308	rRNA metabolic process	1
272363	Clonidium difficile 630	mal	4816295	Q14887	GO:0006399	rRNA metabolic process	0.8911

Figure 2: We developed a new method for the computational annotation of gene functions, which is based on the principles of homology and phylogenetic profiles and was published in the PLOS Computational Biology journal.

corpora, spanning reference corpora of contemporary and historical Slovene, specialized corpora from various domains, multilingual parallel corpora, to several large foreign language corpora.

In the project “Leading Slovene Humanists from the 16th to the mid-19th Century” we continued with our work on IT support, developing a tool to produce digital text-critical editions with Word files as the input and TEI P5 documents as the output. In the new project “Slovenian Literature in Unknown Early Modern Manuscripts: Information Technology Aided Analyses and Scholarly Editions” we started work on the automatic modernization of the diplomatic and critical transcriptions of manuscripts. We also cooperated with the Slovenian Academy of Sciences and Arts on producing their Web-based Slovene Biographical Lexicon.

We continued our work in the context of the ESF network NetWordsS (European Network on Word Structure) and the COST action MUMIA (Multilingual and Multifaceted Interactive Information Access) and joined the new COST action PARSEME (Parsing and Multi-word Expressions). We collaborated in the work of the Slovene Institute of Standardization as the Slovene representatives in ISO/TC37/SC4 (Terminology and Other Language and Content Resources / Language Resources Management) by reviewing, translating and approving Slovene standards from this field. We collaborated with the Slovenian Ministry of Culture in preparing the Action Plan for the National Program for Language Policy 2014-2018 and in taking the steps necessary for Slovenia to join the research infrastructure CLARIN (Common Language Resources and Technology Infrastructure).

In the area of decision support our long-term goal is to develop methods and techniques for decision modeling, support them with software and integrate them with data-mining systems. In 2013 we achieved the most important results in the FP7 project FIRST, in which we developed decision-support models and systems in banking and financial management. One of the solutions is aimed at the detection of fraudulent behavior (the so-called “Pump and Dump” scenarios) in financial transactions. The solution was presented in an awarded conference paper and is implemented in an information system of the project partner bNext from Germany. Another solution is aimed at bank-reputation risk assessment and is used by the project partner Banca Monte dei Paschi di Siena in Italy. Important theoretical and methodological advancements were achieved by the development of new methods for the ranking of alternatives in qualitative multi-attribute models, which are based on copulas; they improve the sensitivity of decision models and alleviate some drawbacks of existing methods. We developed a database of qualitative decision models, which currently contains over 500 models and will serve as an important resource for forthcoming research. We extended and updated our decision-support software: our flagship decision-modeling program DEXi and open-source library JDEXi were upgraded to a new development platform and extended with a number of functions. In addition to the already-mentioned areas of banking and finance, we applied these methods for the evaluation of water sources and cropping systems, and in the area of providing sustainable energy sources in Slovenia until 2030.

We participated in the project EVADIFF (Evaluation et de développement et modèles outils d'aide à la décision utilisés pour la Prévention des pollutions diffuses par les produits phytopharmaceutiques), commissioned by ARVALIS Institut du Végétal, France, where we are developing a decision-support system for the selection of mitigation measures for the protection of surface waters from pollution by phytopharmaceuticals. We have implemented the first validated results as an internet application for the internal use of the ARVALIS institute.

We were the main technological partner in the FP7 project FIRST, which received an excellent score in its final evaluation. For our three-year work on the analysis of financial news, blogs and tweets we received €750,000.



Figure 3: The system for home rehabilitation developed within the FP7 project REWIRE.

Some outstanding publications in the past year

1. Bohanec, M., Bertheau, Y., Brera, C., Gruden, K., Holst-Jensen, A., Kok, E.J., Lécroart, B., Messéan, A., Miraglia, M., Onori, R., Prins, T. W., Soler, L.-G., Žnidaršič, M.: The Co-Extra decision support system: A model-based integration of project results. Genetically modified and non-genetically modified food supply chains: Co-existence and traceability (ed. Bertheau, Y.), Wiley-Blackwell, 2013, 461-489
2. Erjavec, T., Jelovšek, A.: A corpus-based diachronic analysis of Slovene clitics. V: Bennett, P. (ed.). New methods in historical corpora, (Korpuslinguistik und interdisziplinäre Perspektiven auf Sprache = Corpuslinguistics and interdisciplinary perspectives on language). Tübingen: Narr Verlag, 2013, 117-126

3. Grčar, M., Trdin, N., Lavrač, N.: A methodology for mining document-enriched heterogeneous information networks. *The Computer journal*, 2013, vol. 56, no. 3, 321–335
4. Kocev, D., Vens, C., Struyf, J., Džeroski, S.: Tree ensembles for bpredicting structured outputs. *Pattern recognition*, [Print ed.], 2013, vol. 46, no. 3, 817–883.
5. Radivojac, P., Panov, P., Džeroski, S., et al.: A large-scale evaluation of computational protein function prediction. *Nature methods*, 2013, vol. 10, no. 3, 221–227
6. Ramšak, Ž., Baebler, Š., Rotter, A., Korbar, M., Mozetič, I., Usadel, B., Gruden, K.: GoMapMan : integration, consolidation and visualization of plant gene annotations within the MapMan ontology. *Nucleic acids research*, 2013, 9 pgs
7. Sluban, B., Gamberger, D., Lavrač, N.: Ensemble-based noise detection: noise ranking and visual performance evaluation. *Data mining and knowledge discovery*, [in press] 2013, 39 pgs
8. Škunca, N., Bošnjak, M., Kriško, A., Panov, P., Džeroski, S., Šmuc, T.: Phyletic profiling with cliques of orthologs is enhanced by signatures of paralogy relationships. *PLoS computational biology*, 2013, vol. 9, no. 1, e1002852-1–e1002852-14
9. Škraban, J., Džeroski, S., Ženko, B., Mongus, D., Gangl, S., Rupnik, M.: Gut microbiota patterns associated with colonization of different *Clostridium difficile* ribotypes. *PloS one*, 2013, vol. 8, iss. 2, e58005-1–e58005-13
10. Vavpetič, A., Podpečan, V., Lavrač, N.: Semantic subgroup explanations. *Journal of intelligent information systems*, [in press] 2013, 22 pgs

Awards and appointments

1. Marko Bohanec: Best paper reward on International Conference 26th Bled eConference - eInnovation: Challenges and Impacts for Individuals, Organizations and Society
2. Sašo Džeroski, Nikola Simidjievski, Ljupčo Todorovski: Best ICT paper on 5th Jožef Stefan International Postgraduate School Students Conference
3. Nada Lavrač: Zois Recognition Award for her work in intelligent data analysis, Applicant: Committee of the Republic of Slovenia Zois Award
4. Vid Podpečan: The outstanding scientific achievement: Environment Orange4WS for service-oriented data mining, Applicant: Public Research Agency of the Republic of Slovenia (SRA), the Scientific Council for Engineering
5. Nejc Trdin: Award to Organising Committee for creativity, ideas, help and support in organizing 5th Jožef Stefan International Postgraduate School Students Conference, Applicant: Dean and President of Jožef Stefan International Postgraduate School

Organization of conferences, congresses and meetings

1. Project meeting of European project SUMO, Ljubljana, Slovenia, 6.–7. 5. 2013
2. Project meeting of European project FIRST, Dubrovnik, Croatia, 12.–14. 6. 2013
3. Symposium machine learning and computational creativity, Ljubljana, Slovenia, 4. 7. 2013
4. Project meeting of European project MUSE, Ljubljana, Slovenia, 30. 9.–2. 10. 2013

INTERNATIONAL PROJECTS

1. EVADIFF; Evaluation of Existing Models and Development of New Decision-making Tools to prevent Diffuse Pollution caused by Plant Protection Products
Arvalis - Institut du Végétal
Prof. Marko Debeljak
2. 7FP - FIRST; Large Scale Information Extraction and Integration Infrastructure for Supporting Financial Decision Making
European Commission
Prof. Nada Lavrač
3. 7FP - SUMO; Supermodeling by Combining Imperfect Models
European Commission
Prof. Sašo Džeroski
4. 7FP - FOC-II; Forecasting Financial Crises
European Commission
Dr. Igor Mozetič
5. 7FP - REWIRE; Rehabilitative Wayout In Responsive Home Environments
European Commission
Prof. Sašo Džeroski
6. 7FP - MUSE; Machine Understanding for Interactive Storytelling
European Commission
Prof. Nada Lavrač
7. 7FP - PROSECCO; Promoting the Scientific Exploration of Computational Creativity

- European Commission
Prof. Nada Lavrač
8. 7FP - ConCreTe; Concept Creation Technology
European Commission
Prof. Nada Lavrač
9. 7FP - WHIM; The What-If Machine
European Commission
Prof. Nada Lavrač
10. 7FP - DECATHLON; Development of Cost Efficient Advanced DNA-Based Methods for Specific Traceability Issues and High Level On-site Applications
European Commission
Prof. Marko Bohanec
11. 7FP - SIMPOL; Financial Systems Simulation and Policy Modelling
European Commission
Dr. Igor Mozetič
12. 7FP - MULTIPLEX; Foundational Research on Multilevel Complex Networks and Systems
European Commission
Dr. Igor Mozetič
13. COST IC1002; MUMIA; Multilingual and Multifaceted Interactive Information Access
COST Office
Dr. Igor Mozetič
14. The European Network on Word Structure
European Science Foundation
Asst. Prof. Tomaž Erjavec

15. PARSEME: PARsing and Multi-Word Expressions; Towards Linguistic Precision and Computational Efficiency in Natural Language Processing
COST Office
Asst. Prof. Tomaž Erjavec
16. Structured Annotation, Storage and Retrieval of Images and Videos
Slovenian Research Agency
Prof. Sašo Džeroski

RESEARCH PROGRAM

1. Knowledge Technologies
Prof. Nada Lavrač

R&D GRANTS AND CONTRACTS

1. Growth and Defense Trade-offs in Multitrophic Interaction between Potato and Its Two Major Pests
Prof. Nada Lavrač
2. The Leading Humanists in the Slovenian Territory between the 16th and mid-19th Centuries and Their Social and Cultural Environment
Asst. Prof. Tomaž Erjavec

3. Slovenian Literature in Unknown Early Modern Manuscripts: Information-Technology Aided Analyses and Scholarly Editions
Asst. Prof. Tomaž Erjavec
4. Development and Applications of New Semantic Data Mining Methods in Life Sciences
Prof. Nada Lavrač
5. Ecological Restoration of Natural Disturbances in Forests
Prof. Marko Debeljak
6. Workflows in the Cloud
Dr. Darko Cherepnalkoski
7. Sentiment analysis
Dr. Matjaž Juršič
8. Google Digital Humanities Award for "Developing Language Models for Historical Slovenian"
Asst. Prof. Tomaž Erjavec
9. DS/ALT 2014 - The 17th International Conference on Discovery Science and The 25th International Conference on Algorithmic Learning Theory
Prof. Sašo Džeroski

NEW CONTRACT

1. Shallow Semantic Analyses for Selected European Languages
Gama System, d. o. o.
Dr. Igor Mozetič

VISITORS FROM ABROAD

1. Bogdan Okreša Djurić, University of Varaždin, Faculty of Organization and Informatics, Varaždin, 24. 1.-29. 3. 2013
2. Sebastian Dumančić, Zagreb, Croatia, 4.-8. 3. 2013 and 1.-26. 7. 2013
3. Dr. Aalar Kuusik, Tallinn University of Technology, Talin, Estonia, 7. 3. 2013
4. Prof. Filip Železny, Department of Cybernetics, Faculty of Electrical Engineering, Czech Technical University in Prague, Prague, Czech Republic, 24.-26. 3. 2013
5. Prof. Hannu Toivonen, University of Helsinki, Helsinki, Finland, 2.-5. 7. 2013
6. Prof. Juergen Kurths, Potsdam Institute for Climate Impact Research, Potsdam, Germany, 8. 5. 2013
7. Prof. Ljupčo Kocarev, Macedonian Academy of Sciences and Arts, Skopje, Macedonia, 8. 5. 2013
8. Dr. Wim Wiegierinck, Radboud University Nijmegen, Nijmegen, The Netherlands, 8. 5. 2013
9. Dr. David Cornforth, School of Design, Communication and IT, University of Newcastle, Sydney, Australia, 8.-15. 6. 2013
10. Dr. Herbert Jelinek, Khalifa University of Science, Technology & Research (KUSTAR), Abu Dhabi, UAE, 8.-15. 6. 2013
11. Prof. Don Hodges, University of Tennessee, Institute of Agriculture, Knoxville, USA, 20.-24. 5. 2013
12. Dr. Pierre Geurts, University of Liège, Department of Electrical Engineering and Computer Science, Institut Montefiore, Liege, Belgium, 4.-7. 6. 2013
13. Prof. Jochen Rink, Max Planck Institute for Molecular Cell Biology and Genetics, Dresden, Germany, 3.-5. 6. 2013
14. Shang Yun Liu, Max Planck Institute for Molecular Cell Biology and Genetics, Dresden, Germany, 3.-7. 6. 2013
15. Dr. Richard Wheeler, University of Edinburgh, Edinburgh, Scotland, 3.-7. 7. 2013
16. Dr. Benoit Real, Dr. Jonathan Marks-Perreau, ARVALIS - Institut du végétal, Paris, France, 28.-30. 8. 2013
17. Prem Raj Adhikari, Department of Information and Computer Science, Aalto University School of Science, Espoo, Finland, 14.-20. 9. 2013
18. Prof. Marie-Francine Moens, Department of Computer Science Katholieke Universiteit Leuven, Leuven, Belgium, 30. 9.-2. 10. 2013
19. Prof. Marc Cavazza, Teesside University, Middlesbrough, Great Britain, 30. 9.-2. 10. 2013
20. Dr. Tomislav Šmuc, Institut Rudjer Bošković, Zagreb, Croatia, 3.-4. 10. 2013
21. Matija Piškorec, Institut Rudjer Bošković, Zagreb, Croatia, 3.-4. 10. 2013
22. Vinko Zlatič, Institut Rudjer Bošković, Zagreb, Croatia, 3.-4. 10. 2013
23. Dr. Dragan Gamberger, Institut Rudjer Bošković, Zagreb, Croatia, 3.-4. 10. 2014
24. Katarina Trojchanec, Faculty of Computer Science and engineering, University Ss. Cyril and Methodius, Skopje, Macedonia, 29. 10.-28. 11. 2013
25. Ivan Kitanovski, Faculty of Computer Science and engineering, University Ss. Cyril and Methodius, Skopje, Macedonia, 22. 11.-23. 12. 2013
26. Dr. Gjorgji Madjarov Faculty of Electrical Engineering and Information Technologies, University Ss. Cyril and Methodius, Skopje, Macedonia, 14.-22. 12. 2013

STAFF

Researchers

1. Prof. Marko Bohanec
2. Prof. Bojan Cestnik*
3. Prof. Marko Debeljak
4. Prof. Sašo Džeroski
5. Asst. Prof. Tomaž Erjavec
6. **Prof. Nada Lavrač, Head**
7. Prof. Tanja Urbančič*

Postdoctoral associates

8. Dr. Darko Cherepnalkoski
9. Dr. Matjaž Juršič
10. Dr. Dragi Kocev
11. Dr. Petra Kralj Novak
12. Dr. Panče Panov
13. Dr. Vid Podpečan
14. Dr. Ivica Slavkov
15. Dr. Aneta Trajanov
16. Asst. Prof. Bernard Ženko
17. Asst. Prof. Martin Žnidaršič

Postgraduates

18. Miha Grčar, B. Sc.

19. *Dr. Elena Ikonomovska, left 01.02.13*

20. Jan Kralj, B. Sc.
21. Janez Kranjc, B. Sc.
22. Jurica Levatič
23. Dr. Biljana Mileva Boshkoska
24. Aljaž Osojnik
25. Matic Perovšek, B. Sc.
26. Senja Pollak, B. Sc.
27. Nikola Simidjievski, B. Sc.
28. Borut Sluban, B. Sc.
29. Nejc Trdin, B. Sc.
30. Anže Vavpetič, B. Sc.

Technical officer

31. Dr. Igor Mozetič
- Technical and administrative staff**
32. Tina Anžič, B. Sc.
33. Milica Bauer, B. Sc.

Note:

* part-time JSI member

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Darko Aleksovski, Juš Kocijan, Sašo Džeroski, "Model tree ensembles for modeling dynamic systems", In: Discovery science: 16th International Conference, DS 2013, Singapore, October 6-9, 2013, proceedings, *Lect. Notes Comput. Sci.*, vol. 8140, pp. 17-32, 2013.
2. Marko Bohanec, Martin Žnidaršič, Vladislav Rajkovič, Ivan Bratko, Blaž Zupan, "DEX methodology: three decades of qualitative multi-attribute modeling", *Informatica (Ljublj.)*, vol. 37, no. 1, pp. 49-54, 2013.
3. Marianeve Carotenuto *et al.* (28 authors), "Neuroblastoma tumorigenesis is regulated through the Nm23-H1/h-Prune C-terminal interaction", *Scientific reports*, vol. 3, pp. 1351-1-1351-11, 2013.
4. Ivica Dimitrovski, Dragi Kocev, Suzana Loskovska, Sašo Džeroski, "Fast and efficient visual codebook construction for multi-label annotation using predictive clustering trees", *Pattern recogn. lett.*, vol. 38, pp. 38-45, mar. 2013.
5. Ivica Dimitrovski, Dragi Kocev, Suzana Loskovska, Sašo Džeroski, "Fast and scalable image retrieval using predictive clustering trees", In: Discovery science: 16th International Conference, DS 2013, Singapore, October 6-9, 2013, proceedings, *Lect. Notes Comput. Sci.*, vol. 8140, pp. 33-48, 2013.
6. Tomaž Erjavec, "Korpusi in konkordančniki na strežniku nlijs.si", *Slovenščina 2.0*, no. 1, pp. 24-49, 2013.
7. Tomaž Erjavec, "Posodabljanje starejše slovenščine", *Uporab. inform. (Ljublj.)*, vol. 21, no. 4, pp. 186-195, 2013.
8. Dejan Gjorgjevič, Gjorgji Madjarov, Sašo Džeroski, "Hybrid decision tree architecture utilizing local SVMs for efficient multi-label learning", *Int. j. pattern recogn. artif. intell.*, vol. 27, iss. 7, pp. 1351004-1-38, 2013.
9. Miha Grčar, Nejc Trdin, Nada Lavrač, "A methodology for mining document-enriched heterogeneous information networks", *Comput. j.*, vol. 56, no. 3, pp. 321-335, 2013.
10. Matjaž Juršič, Bojan Cestnik, Tanja Urbančič, Nada Lavrač, "HCI empowered literature mining for cross-domain knowledge discovery", In: Human-computer interaction and knowledge discovery in complex, unstructured, big data: proceedings, Third International Workshop, HCI-KDD 2013, Held at SouthCHI 2013, Maribor, Slovenia, July 1-3, 2013, *Lect. Notes Comput. Sci.*, vol. 7947, pp. 124-135, 2013.
11. Dragi Kocev, Sašo Džeroski, "Habitat modeling with single- and multi-target trees and ensembles", *Ecological informatics*, vol. 18, pp. 79-92, nov. 2013.
12. Dragi Kocev, Celine Vens, Jan Struyf, Sašo Džeroski, "Tree ensembles for predicting structured outputs", *Pattern recogn.*, vol. 46, no. 3, pp. 817-833, 2013.
13. Laura Langohr, Vid Podpečan, Marko Petek, Igor Mozetič, Kristina Gruden, Nada Lavrač, Hannu Toivonen, "Contrasting subgroup discovery", *Comput. j.*, vol. 56, no. 3, pp. 289-303, sep. 2013.
14. Nada Lavrač, Petra Kralj Novak, "Relational and semantic data mining for biomedical research", *Informatica (Ljublj.)*, vol. 37, no. 1, pp. 35-39, 2013.
15. Jurica Levatič, Jasna Čurak, Marijeta Kralj, Tomislav Šmuc, Maja Osmak, Fran Supek, "Accurate models for P-gp drug recognition induced from a cancer cell line cytotoxicity screen", *J. med. chem.*, vol. 56, no. 14, pp. 5691-5708, 2013.
16. Jurica Levatič, Sašo Džeroski, Fran Supek, Tomislav Šmuc, "Semi-supervised learning for quantitative structure-activity modeling", *Informatica (Ljublj.)*, vol. 37, no. 1, pp. 173-179, 2013.
17. Matija Ogrin, Jan Jona Javoršek, Tomaž Erjavec, "A register of early modern Slovenian manuscripts", *Journal of the Text Encoding Initiative*, issue 4, pp. 1-13, March 2013.
18. Panče Panov, Larisa N. Soldatova, Sašo Džeroski, "OntoDM-KDD: ontology for representing the knowledge discovery process", In: Discovery science: 16th International Conference, DS 2013, Singapore, October 6-9, 2013, proceedings, *Lect. Notes Comput. Sci.*, vol. 8140, pp. 126-140, 2013.
19. Matic Perovšek, Bojan Cestnik, Tanja Urbančič, Simon Colton, Nada Lavrač, "Towards narrative ideation via cross-context link discovery using banded matrices", In: Advances in intelligent data analysis XII: IDA 2013: 12th International Symposium, London, UK, October 17-19, 2013: proceedings, *Lect. Notes Comput. Sci.* vol. 8207, pp. 333-344, 2013.
20. Matic Perovšek, Anže Vavpetič, Bojan Cestnik, Nada Lavrač, "A wordification approach to relational data mining", In: Discovery science: 16th International Conference, DS 2013, Singapore, October 6-9, 2013, proceedings, *Lect. Notes Comput. Sci.*, vol. 8140, pp. 141-154, 2013.
21. Predrag Radivojac, Panče Panov, Sašo Džeroski, "A large-scale evaluation of computational protein function prediction", *Nature methods*, vol. 10, no. 3, pp. 221-227, 2013.
22. Borut Sluban, Nada Lavrač, "ViperCharts: visual performance evaluation platform", In: Machine learning and knowledge discovery in databases: European Conference, ECML PKDD 2013, Prague, Czech Republic, September 23-27, 2013. Part III: proceedings, *Lect. Notes Comput. Sci.*, vol. 8190, pp. 650-653, 2013.
23. Jasmina Smailović, Miha Grčar, Nada Lavrač, Martin Žnidaršič, "Predictive sentiment analysis of tweets: a stock market application", In: Human-computer interaction and knowledge discovery in complex, unstructured, big data: proceedings, Third International Workshop, HCI-KDD 2013, Held at SouthCHI 2013, Maribor, Slovenia, July 1-3, 2013, *Lect. Notes Comput. Sci.*, vol. 7947, pp. 77-88, 2013.
24. Daniela Stojanova, Michelangelo Ceci, Annalisa Appice, Donato Malerba, Sašo Džeroski, "Dealing with spatial autocorrelation when learning predictive clustering trees", *Ecological informatics*, vol. 13, pp. 22-39, 2013.
25. Daniela Stojanova, Michelangelo Ceci, Donato Malerba, Sašo Džeroski, "Learning hierarchical multi-label classification trees from network data", In: Discovery science: 16th International Conference, DS 2013, Singapore, October 6-9, 2013, proceedings, *Lect. Notes Comput. Sci.*, vol. 8140, pp. 233-248, 2013.
26. Daniela Stojanova, Michelangelo Ceci, Donato Malerba, Sašo Džeroski, "Using PPI network autocorrelation in hierarchical multi-label classification trees for gene function prediction", *BMC bioinformatics*, vol. 14, pp. 285-1-285-18, sep. 2013.
27. Jure Škraban, Sašo Džeroski, Bernard Ženko, Domen Mongus, Simon Gangl, Maja Rupnik, "Gut microbiota patterns associated with colonization of different clostridium difficile ribotypes", *PLoS one*, vol. 8, iss. 2, pp. e58005-1-e58005-13, 2013.
28. Jure Škraban, Sašo Džeroski, Bernard Ženko, Livija Tušar, Maja Rupnik, "Changes of poultry faecal microbiota associated with Clostridium difficile colonisation", *Vet. microbiol.*, vol. 165, iss. 3/4, pp. 416-424, 30 Aug. 2013.
29. Nives Škunca, Matko Bošnjak, Anita Kriško, Panče Panov, Sašo Džeroski, Tomislav Šmuc, "Phyletic profiling with cliques of orthologs is enhanced by signatures of paralogy relationships", *PLOS comput. biol.*, vol. 9, no. 1, pp. e1002852-1-e1002852-14, 2013.
30. Tadej Štajner, Tomaž Erjavec, Simon Krek, "Razpoznavanje imenskih entitet v slovenskem besedilu", In: *Jezikovne tehnologije*, (Slovenščina 2.0, Tematska številka, vol. 1, no. 2), Tomaž Erjavec, ed., Jerneja Žganec Gros, ed., Ljubljana, Trojina, Institute for Applied Slovene Studies, 2013, pp. 58-81.
31. Jovan Tanevski, Ljupčo Todorovski, Yannis Kalaidzidis, Sašo Džeroski, "Inductive process modeling of Rab5-Rab7 conversion in endocytosis", In: Discovery science: 16th International Conference, DS 2013, Singapore, October 6-9, 2013, proceedings, *Lect. Notes Comput. Sci.*, vol. 8140, pp. 265-280, 2013.
32. Anže Vavpetič, Petra Kralj Novak, Miha Grčar, Igor Mozetič, Nada Lavrač, "Semantic data mining of financial news articles", In: Discovery science: 16th International Conference, DS 2013, Singapore, October 6-9, 2013, proceedings, *Lect. Notes Comput. Sci.*, vol. 8140, pp. 294-307, 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

1. Tomaž Erjavec, "Slovene corpora for corpus linguistics and language technologies", In: *Natural language processing, corpus linguistics, e-learning: proceedings*, Seventh International Conference, SLOVAKO 2013, November 13-15, 2013, Bratislava, Slovakia, Katarína Gajdošová, ed., Adriána Žáková, ed., [S. l.], RAM-Verlag, 2013, pp. 51-61.

PUBLISHED CONFERENCE CONTRIBUTION

1. Irina Alić, Michael Siering, Marko Bohanec, "Hot stock or not?, A qualitative multi-attribute model to detect financial market

- manipulation", In: *elnnovation: challenges and impacts for individuals, organizations and society: conference proceedings*, 26th Bled eConference, June 9-13, 2013, Bled, Slovenia, Dianne L. Wigand, ed., et al, Kranj, Moderna organizacija, 2013, pp. 64-77.
2. Marko Bohanec, Giorgio Aprile, Maria Costante, Morena Foti, Nejc Trdin, "Decision support model for assessment of bank reputational risk", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 11-14.
 3. Marko Debeljak, Vladimir Kuzmanovski, Florence Leprince, Benot Réal, Sašo Džeroski, Aneta Trajanov, "Prediction of drainage periods and drainage outflow", In: *YORK 2013: pesticide behaviour in soils, water and air: 2-4 September 2013, York, UK*, York, University of York, 2013, 3 pp..
 4. Tomaž Erjavec, Alenka Jelovšek, "A corpus-based diachronic analysis of Slovene clitics", V: *New methods in historical corpora: [selected papers presented at Conference on New Methods in Historical Corpora, 29th to 30th April 2011, Manchester, UK]*, (Korpuslingvistik und interdisziplinäre Perspektiven auf Sprache = Corpuslinguistics and interdisciplinary perspectives on language, Bd. 3), Paul Bennett, ur., Tübingen, Narr Verlag, 2013, str. 117-126.
 5. Tina Jaklič, Luka Juvančič, Marko Debeljak, "Incorporation of energy analysis into decision-making at the farm level: a conceptual model and its implications for agri-environmental policy design", In: *Emergy synthesis 7: theory and applications of the emergy methodology*, Seventh Biennial Emergy Conference, Gainesville, Florida, January, 12-14, 2012, Mark Theodore Brown, ed., Gainesville, The Center for Environmental Policy, University of Florida, 2013, pp. 283-292.
 6. Aleš Jurca, Sašo Džeroski, "Length dispersion of shoes labelled with the same size in the UK shoe-size system", In: *Proceedings of the Eleventh Footwear Biomechanics Symposium, Natal, Brazil, 2013*, (Footwear science, Vol. 5, suppl. 1, 2013), Abingdon, Taylor & Francis Group, 2013, vol. 5, suppl. 1, pp. S39-S41, 2013.
 7. Dragi Kocev, Ivica Slavkov, Sašo Džeroski, "Feature ranking for multi-label classification using predictive clustering trees", In: *Solving complex machine learning problems with ensemble methods: COPEM - ECML/PKDD 2013 workshop, Prague, 27 September 2013*, Ioannis Katakis, ed., [S. l., s. n.], 2013, pp. 56-68.
 8. Janez Kranjc, Vid Podpečan, Nada Lavrač, "Real-time data analysis in CloudFlows", In: *Proceedings*, 2013 IEEE International Conference on Big Data, 6-9 October 2013, Santa Clara, CA, USA, Xiaohua Hu, ed., Danvers, IEEE = Institute of Electrical and Electronics Engineers, 2013, pp. 15-22.
 9. Vladimir Kuzmanovski, Marko Debeljak, Sašo Džeroski, "Time-window selection for optimal generalization with noise variance reduction in ecological data", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 148-157.
 10. Vladimir Kuzmanovski, Aneta Trajanov, Sašo Džeroski, Benot Réal, Florence Leprince, Marko Debeljak, "Modelling drainage with machine learning methods", In: *YORK 2013: pesticide behaviour in soils, water and air: 2-4 September 2013, York, UK*, York, University of York, 2013, 2 pp..
 11. Jurica Levatič, Dragi Kocev, Sašo Džeroski, "The use of the label hierarchy in HMC improves performance: a case study in predicting community structure in ecology", In: *New frontiers in mining complex patterns*, ECML PKDD European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases, September 23-27, 2013, Prague, Czech Republic, [S. l., s. n.], 2013, pp. 189-201.
 12. Jurica Levatič, Živa Ramšak, Tjaša Stare, Dragi Kocev, Kristina Gruden, Sašo Džeroski, "Gene function prediction for Solanum tuberosum from time-series gene expression data", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 158-167.
 13. Fabien Massé, Anisoara Paraschiv-Ionescu, Bernard Ženko, Sašo Džeroski, Kamiar Aminian, "Lifestyle evaluation using wearable technologies: opportunities for stroke patients", In: *Converging clinical and engineering research on neurorehabilitation*, (Biosystems & Biorobotics), International Conference on Neurorehabilitation, ICNR 2012, Toledo, Spain, November 14-16, 2012, José L. Pons, ed., Diego Torricelli, ed., Marta Pajaro, ed., Heidelberg [etc.], Springer, cop. 2013, vol. 1, pp. 941-945.
 14. Dragana Miljković, Vid Podpečan, Tjaša Stare, Igor Mozetič, Kristina Gruden, Nada Lavrač, "Incremental revision of biological networks from texts", In: *Proceedings*, IWBBIO 2013, International Work-
Conference on Bioinformatics and Biomedical Engineering, March 18-20, 2013, Granada, [S. l., s. n.], 2013, pp. 1-9.
 15. Patrik Mouron, Marko Bohanec, "A multi-attribute decision method for assessing the overall sustainability of crop protection strategies: a case study based on apple production in Europe", V: *Methods and procedures for building sustainable farming systems: [presented at 9th European IFSA Symposium in Vienna, July 2010]*, Oxford, Elsevier, 2013, str. 123-140.
 16. Vid Podpečan, Dragana Miljković, Marko Petek, Tjaša Stare, Kristina Gruden, Igor Mozetič, Nada Lavrač, "Integrating semantic transcriptomic data analysis and knowledge extraction from biological literature", In: *Proceedings*, 2013 IEEE International Conference on Bioinformatics and Biomedicine Workshops BIBM 2013, Shanghai, China, December 18-21, 2013, Danvers, Institute of Electrical and Electronics Engineers, 2013, pp. 477-480.
 17. Yves Scherrer, Tomaž Erjavec, "Modernizing historical Slovene words with character-based SMT", In: *Proceedings of the workshop: ACL 2013: The 4th Biennial International Workshop on Balto-Slavic Natural Language Processing, August 8-9, Sofia, Bulgaria*, The 4th Biennial International Workshop on Balto-Slavic Natural Language Processing, August 8-9, Sofia, Bulgaria, Stroudsburg (PA), Association for Computational Linguistics, 2013, pp. 58-62.
 18. Nikola Simidjievski, Ljupčo Todorovski, Sašo Džeroski, "Learning bagged models of dynamic systems", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 177-188.
 19. Ivica Slavkov, Jana Karcheska, Dragi Kocev, Slobodan Kalajdziski, Sašo Džeroski, "Extending reliefF for hierarchical multi-label classification", In: *New frontiers in mining complex patterns*, ECML PKDD European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases, September 23-27, 2013, Prague, Czech Republic, [S. l., s. n.], 2013, pp. 156-167.
 20. Borut Sluban, Miha Grčar, "URL tree: efficient unsupervised content extraction from streams of web documents", In: *Proceedings*, 22nd ACM International Conference on Information & Knowledge Management, CIKM'13, October 27th - November 1st, 2013, Burlingame, CA, USA, [S. l.], ACM = Association for Computing Machinery, 2013, pp. 2267-2272.
 21. Mateja Škerjanec, Darko Čerepnalkoski, Sašo Džeroski, Boris Kompare, Nataša Atanasova, "Modelling dynamic systems using a hybrid approach", In: *Machine Learning in Water Systems: [Proceedings of the AISB Convention 2013, Exeter, UK, 3-5 April 2013]*, Dragan Savič, ed., Exeter, University of Exeter, 2013, pp. 35-38.
 22. Jovan Tanevski, Ljupčo Todorovski, Sašo Džeroski, "Automated modeling of Rab5Rab7 conversion in endocytosis", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 209-218.
 23. Nejc Trdin, Marko Bohanec, Mitja Janža, "Decision support system for management of water sources", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 118-121.
 24. Anže Vavpetič, Petra Kralj Novak, Nada Lavrač, "Analysing financial vocabulary using a new semantic subgroup discovery system Hedwig", In: *Zbornik*, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 219-229.
 25. Darko Zelenika, Simon Kegljevič, Andrej Dobrovoljc, Janez Povh, Bernard Ženko, Božo Tomas, "Automatic invoice capture in small and medium-sized Slovenian enterprises: project overview", In: *Proceedings*, 5th International Conference on Information Technologies and Information Society [also] ITIS 2013, Dolenjske toplice, 7-9 november 2013, Zoran Levnajič, ed., Novo mesto, Fakulteta za informacijske študije, 2013, pp. 40-46.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Marko Bohanec *et al.* (13 authors), "The Co-Extra decision support system: a model-based integration of project results", In: *Genetically modified and non-genetically modified food supply chains: co-existence and traceability*, Yves Bertheau, ed., Chichester, Blackwell, cop. 2013, pp. 459-489.
2. Tomaž Erjavec, "Vzporedni korpus SPOOK: označevanje, zapis in iskanje terminoloških virov", In: *Slovenski prevodi skozi korpusno prizmo*, (Zbirka Prevodoslovje in uporabno jezikoslovje), Špela Vintar, ed., 1. izd., Ljubljana, Znanstvena založba Filozofske fakultete, 2013, pp. 14-31.
3. Tomaž Erjavec, Darja Fišer, "Jezik slovenskih tvitov: korpusna raziskava", In: *Družbena funkcijskost jezika: (vidiki, merila, opredelitve)*, (Obdobja, 32), Andreja Žele, ed., 1. natis, Ljubljana, Znanstvena založba Filozofske fakultete, 2013, pp. 109-116.
4. Arne Holst-Jensen *et al.* (28 authors), "Towards detection of unknown GMOs", In: *Genetically modified and non-genetically modified food supply chains: co-existence and traceability*, Yves Bertheau, ed., Chichester, Blackwell, cop. 2013, pp. 367-382.
5. Roberta Onori *et al.* (29 authors), "GMO sampling strategies in food and feed chains", In: *Genetically modified and non-genetically modified food supply chains: co-existence and traceability*, Yves Bertheau, ed., Chichester, Blackwell, cop. 2013, pp. 243-272.

MENTORING

1. Biljana Mileva Boshkoska, *From qualitative to quantitative evaluation methods in multi-criteria decision models*: doctoral dissertation, Ljubljana, 2013 (mentor Marko Bohanec).
2. Darko Čerepnalkoski, *Process-based models of dynamical systems: representation and induction*: doctoral dissertation, Ljubljana, 2013 (mentor Sašo Džeroski; co-mentor Ljupčo Todorovski).
3. Matjaž Juršič, *Text mining for cross-domain knowledge discovery*: doctoral dissertation, Ljubljana, 2013 (mentor Nada Lavrač; co-mentor Bojan Cestnik).
4. Dragana Miljković, *Semi-automated knowledge elicitation for modelling plant defence response*: doctoral dissertation, Ljubljana, 2013 (mentor Nada Lavrač; co-mentor Igor Mozetič).
5. Vid Podpečan, *Knowledge discovery in a service-oriented data mining environment*: doctoral dissertation, Ljubljana, 2013 (mentor Nada Lavrač).
6. Branko Jerič, *Modeling of teaching based on projects*: master's thesis, Nova Gorica, 2013 (mentor Bojan Cestnik).
7. Jan Kralj, *A generalization of the Arnoldi algorithm to a nonlinear eigenvalue problem*: master's thesis, Ljubljana, 2013 (mentor Bor Plestenjak).
8. Lucija Vidrih, *Prospects of lifelong learning at the University of Nova Gorica*: master's thesis, Nova Gorica, 2013 (mentor Tanja Urbančič).
9. Aljaž Osojnik, *Modeling dynamical systems with data stream mining*: master's thesis, Ljubljana, 2013 (mentor Sašo Džeroski; co-mentor Andrej Bauer).

DEPARTMENT OF INTELLIGENT SYSTEMS

E-9

The Department of Intelligent Systems develops new methods and techniques for intelligent computer systems, with applications in the areas of the information society, computer science and informatics, and network communication systems. The main research areas are ambient intelligence, computational intelligence, agent and multi-agent systems, and language and speech technologies. The department collaborates closely with the Faculty of Computer and Information Science of the University of Ljubljana on the joint research program "Artificial Intelligence and Intelligent Systems", led by Prof. Ivan Bratko. The department also collaborates closely with industry and contributes significantly the use of intelligent systems in products and services.

Intelligent systems simulate intelligence so that a typical user perceives them as truly intelligent. In reality, these systems use complex mechanisms and implement them on digital computers to imitate human behavior as well as possible, exploiting raw, exponentially growing computer power.

Ambient intelligence is an increasingly established research area introducing technology into our everyday environment in a friendly way that is undemanding for the user. The two key topics of ambient intelligence we work on are (1) telemedicine and elderly care, and (2) smart buildings. On the topic of telemedicine, we successfully completed the European project CHIRON, which is concerned with monitoring chronic heart-disease patients at home. In the past year the project conducted an observational study with real patients, and our department helped analyse the gathered data. We used the CHIRON activity-recognition technology, which utilizes wearable sensors, to win the international EvAAL competition (Evaluating AAL Systems through Competitive Benchmarking). The competition took place in a living laboratory in Velancia, Spain, where an actress performed a sequence of activities, and the competitors had to recognize them with their own equipment. We joined the FP7 project COMMODITY12, which is concerned with monitoring diabetes patients. The role of our department is to analyse the patients' lifestyle with the sensors they use. This means that we will have to recognize their activities and estimate the energy expenditure. While we already have experience with such tasks from the CHIRON project, recognizing high-level activities, such as work, exercise and eating, will be a new challenge for us. Human energy expenditure was estimated with an advanced context-based AI method and presented at the prestigious UbiComp conference. In the ELKOV22 project we collaborate with the Development Center Intech-Les to develop the Intelligent e-Doorman System, which was successfully presented at the Slovenian Innovation Forum. The goal of the system is to utilize intelligent computer methods to offer the services of a human doorman, thus improving the security, comfort and energy efficiency. The e-Doorman is installed on a door with an electro-mechanical lock, sensors, a microcontroller and a tablet computer that serves as the user interface. It uses natural language to communicate with the users, it can learn the users' habits and automatically recognize them, it can detect break-in attempts and other unusual events, and it has a wide range of additional useful functions. In the past year, three pieces of **doctoral research** were completed: on the detection of unusual and suspicious behaviour of people, on the detection of diseases of the elderly, and on combining expert knowledge and machine learning (for the purpose of ambient intelligence).

Computational intelligence is a study of stochastic search, optimization and learning methods, inspired by physical and biological systems. Research in this area at the Department of Intelligent Systems focuses on evolutionary computation methods. We study extensions of evolutionary algorithms for multi-objective optimization and their speedup, and apply these algorithms in engineering design and optimization problems. In doctoral research projects, we develop a method for the visualization of multi-dimensional fronts of non-dominated solutions in multi-objective optimization, an algorithm for the discovery of optimal car-driving strategies with respect to the traveling time, fuel consumption and driving comfort, and optimization based on



Head:
Prof. Matjaž Gams

The department's activity-recognition technology, which uses wearable accelerometers, has won the international EvAAL competition (Evaluating AAL Systems through Competitive Benchmarking).



Figure 1: The winning team at the EvAAL international activity-recognition competition, and a few pictures from the competition.

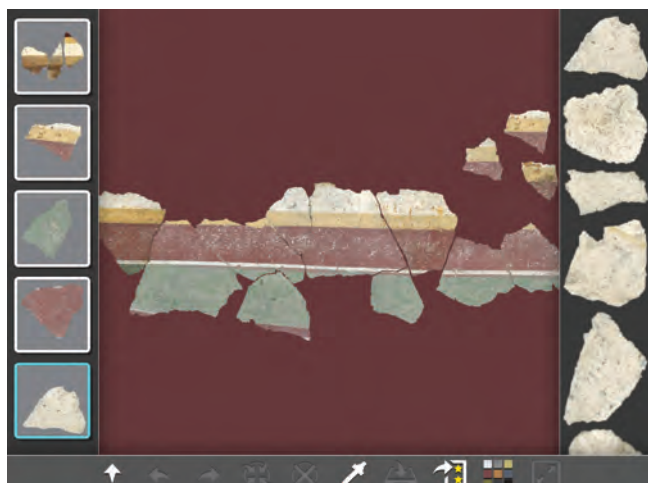


Figure 2: e-Pedius, a mobile and web application for crowdsourced reassembly of wall paintings

agent decision-making architectures and agent-based simulation. The European project ACCUS is aimed at developing an integration and coordination platform for urban systems to build applications across urban systems, provide adaptive and cooperative control for urban subsystems, and to optimize the combined performance. The system will be implemented in Gdansk and Ljubljana. A similar system is studied within the domestic project OPUS, where

The 7th Framework Program project MIRABEL resulted in a computer infrastructure to efficiently balance between the generation and consumption of electrical energy, and supporting the increasing amount of energy from renewable sources.

the focus is on subsystems within a smart house. In the area of agent-based simulation, the project EUSAS is focused on the development of a new approach to mission training for low level units (security, police force, etc.) facing asymmetric threats in an urban environment. The developed tools can be used to discover the common agent strategy by knowing only low-level agent behaviour and possessing basic domain knowledge. The discovered strategic action descriptions are presented to the user in the form of graph paths, agent actions, roles and corresponding rules. Meaningful behaviour patterns are later used in behaviour cloning, where software agents reproduce the observed human behaviour in a specific domain. The clone is tested in the simulator under all circumstances, thus revealing weak spots and later interactively enabling faster human learning.

In the field of **speech and language technologies** we work on speech synthesis, semantic analysis of text and question answering. Together with the Amebis company, we develop a new speech synthesizer for Slovene. Special attention is paid to the requirements of elderly, handicapped and visually impaired people. In the past year, we labelled a phonetically rich and balanced speech database for corpus-based speech synthesis using automatic speech-recognition methods. The speech database was recorded in cooperation with the national television and radio, RTV Slovenia. We have established a free text-to-speech conversion service.



Figure 3: Opening of the 16th International Multiconference Information Society – IS 2013 at the Jožef Stefan Institute.

Focus points of developmental and research potential of the department are also being expressed over successfully developed, integrated and deployed solutions, available on major digital platforms and applicable to a wide population of users. The methods used in typical applied projects combine procedures of intelligent agents, statistical methods and machine learning, and they serve as a base for user interfaces on telephones, pads or desktop computers. Projects' services are developed for all key mobile platforms, i.e., Android, iOS, Windows 8 and BlackBerry, and through classic web clients. In the past year, the department obtained and successfully carried out for four innovative projects concerned with the development of e-services and mobile applications for public and private non-profit organizations:

e-Turist (<http://www.e-turist.si/>) is an application for preparing tourist itineraries adapted to individual users' interests. It takes into account the location, the available time and the opening hours of the attractions. The itineraries are prepared with the help of a recommender system that evaluates the relevance of attractions for each tourist with the help of expert knowledge and the ratings entered in the past by visitors with similar tastes.

The application helps the users to navigate during the trip, and provides them with written and spoken descriptions of the attractions.

e-Asistent (<http://www.projekt-asistent.si>) is an intelligent assistant capable of communication in natural language that aims to help the user when searching for information on a web page. The assistant platform can be quickly installed on web pages, e.g., of municipalities and of various associations, so that the general base is adapted within a few days to the target content. The service also accepts the user feedback with comments and answer quality, which is in turn assessed and reported to the contracting authority. E-Asistent is implemented at the Slovene Federation of Pensioners' Associations (ZDUS) and 10 municipalities, the plan in 2014 is to apply it on 100 municipalities. A similar system Svizec is applied at the Education, Science and Culture Trade Union of Slovenia (SVIZ).

e-Pedius (<http://e-pedius.si/>) is a mobile and web application named after the Roman painter Quintus Pedius. It is a solution that supports crowd-sourcing in assembling the fragments of wall paintings. The restoration of wall paintings from fragments of archaeological sites is difficult due to a large number of fragments, their damage and missing parts, hence it usually requires years of manual expert labour. The new solution e-Pedius is accessible to the wider public, including non-specialists, who can use it to reassemble fragments into new compositions, continue the work of other users, and rate the compositions. The solution is designed as a mobile game in which the users gain points for their achievements, and are encouraged to collaborate with other users.

e-Govorec (<http://dis.ijs.si/e-govorec>) is a mobile application for the voice interpretation of various Slovenian digital texts. The service enables providers with a wide range of e-content to dynamically deliver information in the spoken form of Slovenian language. e-Govorec comes with an integrated synthesizer of speech and is freely available to any user. The application is built with an ear for groups of people with special needs, such as visually impaired and the elderly.

From 7 to 11 October 2013, the 16th **International Multiconference Information Society – IS 2013** took place at the Jožef Stefan Institute. It consisted of nine independent conferences with 182 papers. Four conference awards were given: for exceptional contribution to the development and promotion of the information society, for current achievements in the field of information society, and the information strawberry and lemon for the best and worst public information-society services. At the main innovation fair in Slovenia we were the only institution presenting tree systems at the final event.

In 2013, the achievements of the department were 12 times presented on national TV, indicating attractive research and development.

Some outstanding publications in the past year

1. Depolli, M., Trobec, R., Filipič, B.: Asynchronous master-slave parallelization of differential evolution for multiobjective optimization. *Evolutionary Computation*, 21 (2013), 2, 261–291
2. Dovgan, E., Javorski, M., Tušar, T., Gams, M., Filipič, B.: Comparing a multiobjective optimization algorithm for discovering driving strategies with humans. *Expert Systems with Applications*, 40 (2013), 7, 2687–2695
3. Kozina, S., Gjoreski, H., Gams, M., Luštrek, M.: Three-layer activity recognition combining domain knowledge and meta-classification. *Journal of Medical and Biological Engineering* 33 (2013), 4, 406–414
4. Gjoreski, H., Kaluža, B., Gams, M., Milič, R., Luštrek, M.: Ensembles of multiple sensors for human energy expenditure estimation. *The 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing, UbiComp*, (2013), 359–362
5. B. Kaluža.: *Instant Weka How-to*. Packt Publishing, 2013

Awards and appointments

1. Matjaž Gams, Hristijan Gjoreski, Simon Kozina, Mitja Luštrek: 1st place at the international activity-recognition competition, EvAAL 2013 (Evaluating AAL Systems through Competitive Benchmarking), Norrköping, Sweden, The AAL Open Association, RAREFall

Organization of conferences, congresses and meetings

1. 22nd Slovene Workshop on Nature-Inspired Algorithms, AVN, Šmarna gora, Slovenia, 21. 5. 2013
2. 5th Jožef Stefan International Postgraduate School Students Conference, Jožef Stefan Institute, Ljubljana, Slovenia, 23. 5. 2013

ACCUS smart-city system will design and implement applications for Ljubljana and Gdansk. In a way a similar system OPUS designed for intelligent houses is being developed with the company Robotina. Intelligent control enables a 3 to 20% decrease in costs.

3. Co-organization of the student workshop at the conference GECCO 2013 (Genetic and Evolutionary Computation Conference), Amsterdam, The Netherlands, 6.-10. 7. 2013
4. Workshop for municipalities on the usage of the e-service Asistent, 25. 7. 2013
5. Workshop for municipalities on the usage of the e-service Asistent, 26. 9. 2013
6. 16th International Multiconference Information Society, IS 2013, 7.-11. 10. 2013; independent conferences:
 - Intelligent systems
 - Facing demographic challenges
 - Collaboration, software and services in information society
 - Cognitive sciences
 - Data mining and data warehouses
 - Education in information society
 - Human-computer interaction in information society
 - Cognitonics
 - Matcos 2013
7. Workshop for municipalities on the usage of the e-service Asistent, 18. 11. 2013

Patent granted

1. Gregor Černe, Mitja Bizjak, Bogdan Filipič, Tea Tušar, Erik Dovgan, A system for offer selection and request formation in demand response and distributed production of electrical energy, SI24057 (A), Urad RS za intelektualno lastnino, 30.10.2013.
2. Matjaž Gams, Rok Piltaver, Erik Dovgan, Andrej Planina, Gašper Pintarič, Bogdan Pogorelc, Intelligent surveillance system and procedure for detection of unusual behaviour, SI23855 (A), Urad RS za intelektualno lastnino, 28.2.2013.

INTERNATIONAL PROJECTS

1. 7FP - MIRACLE, MIRABEL; Micro-Request-Based Aggregation, Forecasting and Scheduling of Energy Demand, Supply and Distribution
European Commission
Prof. Bogdan Filipič
2. 7FP - IntellAct; Intelligent Observation and Execution of Actions and Manipulation
European Commission
Prof. Matjaž Gams
3. 7FP - Xperience; Robots Bootstrapped through Learning from Experience
European Commission
Prof. Matjaž Gams
4. 7FP - Commodity12; Continuous Multi-Parametric and Multi-Layered Analysis of Diabetes Type 1&2
European Commission
Dr. Mitja Luštrek
5. EUSAS; European Urban Simulation for Asymmetric Scenarios
EADS N.V., Defence and Security Systems
Prof. Matjaž Gams

7. Virtual Assistant for Municipalities and Societies
Prof. Matjaž Gams
8. ARTEMIS, CHIRON; Cyclic and Person-Centric Health Management: Integrated Approach for Home, Mobile and Clinical Environments
Dr. Mitja Luštrek
9. Adaptive Cooperative Control in Urban (Sub)Systems
Prof. Matjaž Gams
10. COgnitive & Perceptive CAMeraS: COPCAMS
Prof. Bogdan Filipič
11. Optimizing the Management of Energy Efficient Smart Buildings
Dr. Tomaž Šef
12. Research on Adaptive Predictive Domain Models
Dr. Boštjan Kaluža

RESEARCH PROGRAM

1. Artificial Intelligence and Intelligent Systems
Prof. Matjaž Gams

R&D GRANTS AND CONTRACTS

1. Advanced Modelling and Simulation of Liquid-Solid Processes
Prof. Bogdan Filipič
2. Simulation and Optimization of Casting, Rolling and Heat Treatment Processes for Competitive Production of Topmost Steels
Prof. Bogdan Filipič
3. Open Communication Platform for Service Integration: CC OPCOMM
Prof. Matjaž Gams
4. E-Reader in Slovene for the Blind and Visually Impaired
Dr. Tomaž Šef
5. Crowdsourcing Support for Reassembly of Wall Painting Fragments
Prof. Bogdan Filipič
6. Electronic Mobile Tourist Guide
Dr. Mitja Luštrek

NEW CONTRACTS

1. Research of Intelligent Algorithms Applicability for Sensor Data Processing on Embedded Devices
Elgoline, d. o. o.
Prof. Matjaž Gams
2. Research of Intelligent Algorithms Applicability for Sensor Data Processing on Embedded Devices
Store Steel, d. o. o.
Prof. Bogdan Filipič
3. Intelligent Methods for Prediction of Calibration Timing
Špica International, d. o. o.
Prof. Matjaž Gams
4. Analysis and Evaluation of Advanced Spoken Language Technologies for Smart Buildings
Amebis, d. o. o., Kamnik
Dr. Tomaž Šef
5. Industrial Research aimed at Upgrading the eCampus Learning Management System B2, d. o. o.
Prof. Bogdan Filipič
6. User-Oriented Business Reporting
Result, d. o. o.
Prof. Matjaž Gams
7. Critical Analysis and Evaluation of Multiobjective Optimization and Machine Learning Methods for Intelligent Home Services
Robotina d. o. o.
Dr. Tomaž Šef
8. Analysis of Shopping Behavior of Customers in Online Stores
Creatim Ržišnik Perc, d. o. o.
Dr. Mitja Luštrek

VISITORS FROM ABROAD

1. Yves Lesteven, University of Paris Sud XI, Paris, France, 7. 4.-6. 7. 2013
2. Lucas Drai, Etienne Bohrer, University of Paris Sud XI, Paris, France, 3. 6.-31. 8. 2013
3. Martin Gjoreski, Faculty of Computer Science and Engineering, Univerzitet Sv. Kiril in Metodij, Skopje, Macedonia, 1.-31. 7. 2013
4. Ondrej Fikar, Faculty of Electrical Engineering - FEL, Plzen, Plzen, Czech Republic, 2.-31. 7. 2013
5. Wojciech Edward Smietana, Faculty of Computing and Engineering, University of Ulster, Belfast, Great Britain, 14. 8.-30. 9. 2013
6. Prof. Ronald Sladky, Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Austria, 7.-11. 10. 2013
7. Xavier Labanard, Hadji Bouchelaghem, University of Paris Sud XI, Paris, France, 26. 10. 2013- 5. 1. 2014

STAFF

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1. Prof. Ivan Bratko*
2. Asst. Prof. Aleš Dobnikar*
3. Prof. Bogdan Filipič
4. **Prof. Matjaž Gams, Head**
5. Dr. Mitja Luštrek
6. Dr. Domen Marinčič*
7. Dr. Tomaž Šef

Postdoctoral associates

8. Dr. Andraž Bežek*, left 01.07.13
9. Dr. Matija Drobnič*, left 01.02.13
10. Dr. Anton Gradišek
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13. Dr. Aleksander Pivk*
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15. Robert Blatnik, M. Sc.
16. Božidara Cvetković, B. Sc.
17. Erik Dovgan, B. Sc.
18. Tomaž Kompara*, B. Sc.
19. Simon Kozina, B. Sc.

20. Dr. Jana Krivec*
21. Damjan Kužnar, B. Sc.
22. Dr. Violeta Mirchevska
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27. Tea Tušar, M. Sc.
28. Jernej Zupančič, B. Sc.

Technical officers

29. Mitja Kolbe*, B. Sc., left 01.07.13
30. Blaž Mahnič, B. Sc.
31. Gašper Pintarič*, B. Sc.

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34. Liljana Lasič
35. Lana Zemljak

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* part-time JSI member

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Marko Bohanec, Martin Žnidaršič, Vladislav Rajkovič, Ivan Bratko, Blaž Zupan, "DEX methodology: three decades of qualitative multi-attribute modeling", *Informatica (Ljublj.)*, vol. 37, no. 1, pp. 49-54, 2013.
2. Božidara Cvetković, Boštjan Kaluža, Radoje Milič, Mitja Luštrek, "Towards human energy expenditure estimation using smart phone inertial sensors", In: Ambient intelligence: 4th International Joint Conference, Aml 2013, Dublin, Ireland, December 3-5, 2013: proceedings, *Lect. Notes Comput. Sci.*, vol. 8309, pp. 94-108, 2013.
3. Božidara Cvetković, Simon Kozina, Boštjan Kaluža, Mitja Luštrek, "Energy expenditure estimation DEMO application", In: Ambient intelligence: 4th International Joint Conference, Aml 2013, Dublin, Ireland, December 3-5, 2013: proceedings, *Lect. Notes Comput. Sci.*, vol. 8309, pp. 281-286, 2013.
4. Matjaž Depolli, Roman Trobec, Bogdan Filipič, "Asynchronous master-slave parallelization of differential evolution for multiobjective optimization", *Evol. comput.*, vol. 21, no. 2, pp. 261-291, 2013.
5. Sara Dolci, Vincenzo Ieraldi, Anton Gradišek, Zvonko Jagličić, Maja Remškar, Tomaž Apih, Mario Cifelli, Guido Pampaloni, Carlo Alberto Veracini, Valentina Domenici, "Precursors of magnetic resonance imaging contrast agents based on cystine-coated iron-oxide nanoparticles", *Current physical chemistry*, vol. 3, no. 4, pp. 493-500, 2013.
6. Erik Dovgan, Matija Javorski, Tea Tušar, Matjaž Gams, Bogdan Filipič, "Comparing a multiobjective optimization algorithm for discovering driving strategies with humans", *Expert syst. appl.*, vol. 40, no. 7, pp. 2687-2695, 2013.
7. Bogdan Filipič, Risto Vesanen, Erkki Laitinen, "Scalar vs. vector approach to bi-objective resource allocation in spatially distributed networks", *International journal of innovative computing and applications*, vol. 5, no. 3, pp. 191-197, 2013.
8. Iztok Fister, Marjan Mernik, Bogdan Filipič, "Graph 3-coloring with a hybrid self-adaptive evolutionary algorithm", *Computat. optimiz. appl.*, vol. 54, iss. 3, pp. 741-770, 2013.
9. Matjaž Gams, "Alan Turing, Turing machines and stronger", *Informatica (Ljublj.)*, vol. 37, no. 1, pp. 9-14, 2013.
10. Anton Gradišek, Tomaž Apih, Valentina Domenici, Vladimíra Novotná, Pedro J. Sebastião, "Molecular dynamics in a blue phase liquid crystal: a ¹H fast field-cycling NMR relaxometry study", *Soft matter*, vol. 9, no. 45, pp. 10746-10753, 2013.
11. Anton Gradišek, Dorthe Ravnsbæk, Stanislav Vrtnik, Andraž Kocjan, Janez Lužnik, Tomaž Apih, Torben R. Jensen, Alexander V. Skripov, Janez Dolinšek, "NMR study of molecular dynamics in complex metal borohydride LiZn₂(BH₄)₅", *The journal of physical chemistry. C, Nanomaterials and interfaces*, vol. 117, no. 41, pp. 21139-21147, 2013.
12. Vida Groznik, Matej Guid, Aleksander Sadikov, Martin Možina, Dejan Georgiev, Veronika Kragelj, Samo Ribarič, Zvezdan Pirtošek, Ivan Bratko, "Elicitation of neurological knowledge with argument-based machine learning", *Artif. intell. med.*, vol. 57, no. 2, spec. iss., pp. 133-144, 2013.
13. Matej Guid, Ivan Bratko, "Search-based estimation of problem difficulty for humans", In: Artificial intelligence in education: AIED 2013: 16th International Conference, Memphis, TN, USA, July 9-13, 2013: proceedings, *Lect. Notes Comput. Sci.*, vol. 7926, pp. 860-863, 2013.
14. Tadej Janež, Jure Žabkar, Martin Možina, Ivan Bratko, "Learning faster by discovering and exploiting object similarities", *Int. j. adv. robot. syst. (Online)*, vol. 10, pp. 1-18, 2013.
15. Simon Kozina, Hristijan Gjoreski, Matjaž Gams, Mitja Luštrek, "Three-layer activity recognition combining domain knowledge and meta-classification", *J. med. biol. eng.*, vol. 33, no. 4, pp. 406-414, 2013.
16. Mitja Luštrek et al. (16 authors), "Epitope predictions indicate the presence of two distinct types of epitope-antibody-reactivities determined by epitope profiling of intravenous immunoglobulins", *PLoS one*, vol. 8, no. 11, pp. e78605-1- e78605-15, 2013.
17. Aleksander Pivk, Olegas Vasilecas, Diana Kalibatiene, Rok Rupnik, "On approach for the implementation of data mining to business process optimisation in commercial companies", *Technol. econ. dev. econ. (Spausd.)*, vol. 19, no. 2, pp. 237-256, June 2013.
18. Bogdan Pogorelc, Matjaž Gams, "Detecting gait-related health problems of the elderly using multidimensional dynamic time warping approach with semantic attributes", *Multimedia tools and applications*, vol. 66, no. 1, pp. 95-114, 2013.
19. Bogdan Pogorelc et al. (11 authors), "Ambient bloom: new business, content, design and models to increase the semantic ambient media experience", *Multimedia tools and applications*, vol. 66, no. 1, pp. 7-32, 2013.

20. Matej Pregelj, Peter Jeglič, Andrej Zorko, Oksana Zaharko, Tomaž Apih, Anton Gradišek, Matej Komelj, Helmuth Berger, Denis Arčon, "Evolution of magnetic and crystal structures in the multiferroic FeTe₂O₅Br", *Phys. rev., B, Condens. matter mater. phys.*, vol. 87, no. 14, pp. 144408-1-144408-8, 2013.
21. Héctor Solar, Erik Fernández, Gennaro Tartarisco, Giovanni Pioggia, Božidara Cvetković, Simon Kozina, Mitja Luštrek, Jure Lampe, "A non invasive, wearable sensor platform for multi-parametric remote monitoring in CHF patients", *Health technol. (Internet)*, vol. 3, no. 2, str. 99-109, 2013.
22. Vedrana Vidulin, "Searching for credible relations in machine learning", *Informatica (Ljublj.)*, vol. 37, no. 3, pp. 355-356, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Carlos Cavero Barca, Juan Mario Rodríguez, Paolo Emilio Paddu, Mitja Luštrek, Božidara Cvetković, Maurizio Bordone, Eduardo Soudah, Aitor Moreno, Pedro de la Peña, Alberto Rugnone, "Advanced Medical Expert Support Tool (A-MEST): EHR-based Integration of multiple risk assessment solutions for congestive heart failure patients", In: *XIII Mediterranean Conference on Medical and Biological Engineering and Computing 2013: [also] MEDICON 2013, 25-28 September 2013, Seville, Spain*, (IFMBE proceedings, vol. 41), Laura Maria Roa Romero, ed., Heidelberg [etc.], Springer, cop. 2014, pp. 1334-1337.
2. Božidara Cvetković, Boštjan Kaluža, Hristijan Gjoreski, Mitja Luštrek, "Hybrid recommender system for personalized POI selection", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 19-22.
3. Božidara Cvetković, Mitja Luštrek, "Estimation of human energy expenditure using inertial sensors and heart rate sensor", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference*, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 116-125.
4. Gregor Čepin, Tea Tušar, Bogdan Filipič, "Iskanje podobnih enobarvnih fragmentov pri množičnem sestavljanju stenskih poslikav", In: *Zbornik dvaindvajsete mednarodne Elektrotehniške in računalniške konference ERK 2013, 16.-18. september 2013, Portorož, Slovenija*, (Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2013, zv. B, pp. 73-76.
5. Erik Dovgan, Damjan Kužnar, Matjaž Gams, "Analiza možnosti nadgradnje obstoječih sistemov za kalibracijo naprav z inteligentnimi metodami za napovedovanje rokov kalibracije", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 31-34.
6. David Aleksander Fabjan, Vedrana Vidulin, "Long-term-care and intelligent IT in a changing demographic landscape", In: *Soočanje z demografskimi izzivi: zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-8. oktober 2013, Ljubljana, Slovenija: zvezek B: proceedings of the 16th International Multiconference Information Society - IS 2013, October 7th-8th, 2013, Ljubljana, Slovenia: volume B*, Janez Malačič, ed., Matjaž Gams, ed., Ljubljana, Institut Jožef Stefan, 2013, pp. 9-12.
7. Ondřej Fikar, Boštjan Kaluža, Matjaž Gams, "An overview of multiagent platforms", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 35-38.
8. Bogdan Filipič, Tea Tušar, "Challenges of applying optimization methodology in industry", In: *GECCO '13: proceeding of the Fifteenth Annual Conference on Genetic and Evolutionary Computation Conference, Amsterdam, Netherlands, July 06-10, 2013*, New York, ACM, 2013, pp. 1103-1104.
9. Matjaž Gams, Jure Grabnar, Vedrana Vidulin, "Vpliv pravic istospolno usmerjenih na stopnjo rodnosti", In: *Soočanje z demografskimi izzivi: zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-8. oktober 2013, Ljubljana, Slovenija: zvezek B: proceedings of the 16th International Multiconference Information Society - IS 2013, October 7th-8th, 2013, Ljubljana, Slovenia: volume B*, Janez Malačič, ed., Matjaž Gams, ed., Ljubljana, Institut Jožef Stefan, 2013, pp. 13-17.
10. Hristijan Gjoreski, Božidara Cvetković, Boštjan Kaluža, Mitja Luštrek, "Sightseeing route planning", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 39-42.
11. Hristijan Gjoreski, Boštjan Kaluža, Matjaž Gams, Radoje Milić, Mitja Luštrek, "Ensembles of multiple sensors for human energy expenditure estimation", In: *UBICOMP 2013, The 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, September 8-12, 2013, Zurich, Switzerland, Washington, Association for Computing Machinery = ACM, pp. 359-362.
12. Hristijan Gjoreski, Simon Kozina, Matjaž Gams, Mitja Luštrek, "Potential usage of smartphone inertial sensors in healthcare applications", In: *Zbornik, 5. študentska konferenca Mednarodne podiplomske šole Jožefa Stefana = 5th Jožef Stefan International Postgraduate School Students Conference*, 23. maj 2013, Ljubljana, Slovenija, Nejc Trdin, ed., et al, Ljubljana, Mednarodna podiplomska šola Jožefa Stefana, 2013, pp. 126-135.
13. Martin Gjoreski, Hristijan Gjoreski, Rok Piltaver, Matjaž Gams, "Predicting the arrival and the departure time of an employee", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 43-46.
14. Anton Gradišek, Matjaž Gams, "Uporaba inteligentnih mobilnih naprav za individualno medicinsko diagnostiko", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 51-54.
15. Matej Guid, Martin Možina, Ciril Bohak, Aleksander Sadikov, Ivan Bratko, "Building an intelligent tutoring system for chess endgames", In: *CSEU 2013, [S. l.], SCITEPRESS - Science and Technology Publication*, cop. 2013, pp. 263-266.
16. Igor Jurinčič, Anton Gosar, Mitja Luštrek, Boštjan Kaluža, Simon Kerma, Gregor Balažič, "E-tourist: electronic mobile tourist guide", In: *Peace, culture and tourism: collection of papers*, Novi Sad, Faculty of Sciences, Department of Geography, Tourism and Hotel Management, 2013, pp. 182-191.
17. Valentin Koblar, Bogdan Filipič, "Designing a quality-control procedure for commutator manufacturing", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 55-58.
18. Tomaž Kompara, Jernej Zupančič, Matjaž Gams, "Identifikacija oseb na podlagi oblike telesa", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 59-62.
19. Sanja Kovač, Vedrana Vidulin, "Android design principles and their use in application e-doorman", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 63-66.
20. Simon Kozina, Hristijan Gjoreski, Matjaž Gams, Mitja Luštrek, "Efficient activity recognition and fall detection using accelerometers", In: *Evaluating AAL systems through competitive benchmarking: International Competitions and Final Workshop, EvAAL 2013, July and September 2013, [Madrid, Valencia]: proceedings*, (Communications in Computer and Information Science, 386), Juan A. Botía, ed., Heidelberg [etc.], Springer, 2013, pp. 13-23.
21. Simon Kozina, Rok Piltaver, Damjan Kužnar, Matjaž Gams, "Implementacija virtualnega asistenta v sistem e-vratar", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 67-70.
22. Simon Kozina, Paolo Emilio Puddu, Mitja Luštrek, "System for supporting clinical professionals dealing with chronic disease patients", In: *Evolving Ambient Intelligence: Aml 2013 Workshops, Dublin, Ireland, December 3-5, 2013: revised selected papers*, (Communications in computer and information science, 413), Michael J. OGrady, ed., Cham [etc.], Springer, 2013, pp. 78-85.
23. Damjan Kužnar, Aleš Tavčar, Matjaž Gams, "Virtualni asistent", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 71-74.
24. Mitja Luštrek, Boštjan Kaluža, Božidara Cvetković, Hristijan Gjoreski, "E-turist: inteligentni elektronski turistični vodnik", In: *Zbornik 16. mednarodne multikonference Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A*, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 75-78.
25. Violeta Mirchevska, Igor Korelič, Franc Škedelj, Matjaž Gams, "A predictive-analytics system-design", In: *Zbornik 16. mednarodne*

- multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 83-85.*
26. Miha Mlakar, Tea Tušar, Bogdan Filipič, "Primerjava rešitev ob negotovosti v večkriterijski optimizaciji", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 86-89.*
 27. Rok Piltaver, Tadej Vodopivec, Matjaž Gams, "Identifikacija oseb ob vstopu skozi vrata z uporabo pospeškomera in strojnega učenja", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 90-93.*
 28. Marko Pušnik, Rok Piltaver, Vedrana Vidulin, Matjaž Gams, "Inteligentni sistem e-vratar", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 94-97.*
 29. Tomaž Šef, "Storitev e-govorec - govorni bralnik slovenskih besedil", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 106-109.*
 30. Tomaž Šef, Rok Piltaver, Tea Tušar, "Projekt "OpUS", optimizacija upravljanja energetsko učinkovitih pametnih stavb", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 110-113.*
 31. Maja Škrjanc, Klemen Kenda, Gašper Pintarič, "Event processing in asset management", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 176-179.*
 32. Aleš Tavčar, Rok Piltaver, Domen Zupančič, Tomaž Šef, Matjaž Gams, "Modeliranje navad uporabnikov pri vodenju pametnih hiš", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 114-117.*
 33. Tea Tušar, Bogdan Filipič, "An approach to visualizing the 3D empirical attainment function", In: *GECCO '13: proceeding of the Fifteenth Annual Conference on Genetic and Evolutionary Computation Conference, Amsterdam, Netherlands, July 06-10, 2013*, New York, ACM, 2013, pp. 1367-1372.
 34. Tea Tušar, Bogdan Filipič, Erik Dovgan, Blaž Mahnič, Gregor Čepin, Jelka Kuret, Petra Benedik, Asparuh Mihailov, Gregor Berginc, Daniel Vladušič, "Aplikacija e-Pedius za podporo množičnemu sestavljanju fragmentov stenskih poslikav", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 122-125.*
 35. Vedrana Vidulin, Rok Piltaver, Matjaž Gams, "Pregled inteligentnih algoritmov za procesiranje senzorskih podatkov", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 126-129.*
 36. Domen Zupančič, Matjaž Gams, Mitja Luštrek, "Vmesnik za povezavo simuliranega sistema stavbne avtomatike z več agentnim sistemom vodenja", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 130-133.*
 37. Jernej Zupančič, Erik Dovgan, Bogdan Filipič, Rok Pirnat, "Mere uspešnosti v sistemih za e-izobraževanje", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 138-141.*
 38. Jernej Zupančič, Boštjan Kaluža, Matjaž Gams, "Projekt ACCUS: adaptivna kooperativna kontrola urbanih podsistemov", In: *Zbornik 16. mednarodne multikonferenca Informacijska družba - IS 2013, 7.-11. oktober 2013 [Ljubljana, Slovenija]: zvezek A: volume A, Matjaž Gams, ed., et al, Ljubljana, Institut Jožef Stefan, 2013, pp. 134-137.*

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Darja Fišer, Aleš Tavčar, "Več glav več ve: uporaba množičenja za čiščenje sloWNeta", In: *Družbena funkcijskost jezika: (vidiki, merila,*

- opredelitve)*, (Obdobja, 32), Andreja Žele, ed., 1. natis, Ljubljana, Znanstvena založba Filozofske fakultete, 2013, pp. 125-132.
2. Sanjay Modgil *et al.* (19 authors), "The added value of argumentation", In: *Agreement technologies*, (Law, governance and technology series, 8), Sascha Ossowski, ed., Dordrecht, Springer, 2013, pp. 357-403.
3. Bogdan Pogorelc, Matjaž Gams, "Discovering the chances of health problems and falls in the elderly using data mining", In: *Advances in chance discovery: extended selection from international workshops*, (Studies in computational intelligence, 423), Yukio Ohsawa, ed., Akira Abe, ed., Berlin, Heidelberg, Springer, 2013, pp. 163-176.
4. Domen Zupančič, Mitja Luštrek, Matjaž Gams, "A network of sensor and actuator agents for building automation systems", In: *Human aspects in ambient intelligence: contemporary challenges and solutions*, (Atlantis ambient and pervasive intelligence, vol. 8), Tibor Bosse, ed., Amsterdam, Atlantis Press, 2013, pp. 121-132.

SCIENTIFIC MONOGRAPH

1. Boštjan Kaluža, *Instant Weka How-to*, Birmingham, Packt Publishing, 2013.

PATENT APPLICATION

1. Matjaž Gams, Rok Piltaver, Hristijan Gjoreski, *Method for Identification of Persons Entering a Room*, P-201300281, Urad RS za intelektualno lastnino, 19.9.2013.
2. Aleš Moljk, Igor Gornik, Janez Poje, Mitja Virant, Matjaž Gams, Rok Piltaver, Domen Marinčič, Tomaž Kompara, *Interactive door system*, P-201300044, Urad RS za intelektualno lastnino, 1.3.2013; PCT/IB2013/055990, World Intellectual Property Organization, 22.7.2013.

PATENT

1. Gregor Černe, Mitja Bizjak, Bogdan Filipič, Tea Tušar, Erik Dovgan, *A system for offer selection and request formation in demand response and distributed production of electrical energy*, SI24057 (A), Urad RS za intelektualno lastnino, 30.10.2013.
2. Aleš Moljk, Rok Piltaver, Erik Dovgan, Andrej Planina, Gašper Pintarič, Bogdan Pogorelc, *Intelligent surveillance system and procedure for detection of unusual behaviour*, SI23855 (A), Urad RS za intelektualno lastnino, 28.2.2013.

MENTORING

1. Tadej Janež, *Discovering clusters of related learning tasks for improving prediction models of individual tasks*: doctoral dissertation, Ljubljana, 2013 (mentor Ivan Bratko).
2. Boštjan Kaluža, *Detection of anomalous and suspicious behavior patterns from spatio-temporal agent traces*: doctoral dissertation, Ljubljana, 2013 (mentor Matjaž Gams; co-mentor Mitja Luštrek).
3. Aljaž Košmerlj, *Autonomous Modeling of Robot Actions through Discovery of Abstract Concepts*: doctoral dissertation, Ljubljana, 2013 (mentor Ivan Bratko).
4. Jana Krivec, *Cognitive information processing: Game of chess case study*: doctoral dissertation, Ljubljana, 2012 (mentor Grega Repovš; co-mentor Ivan Bratko).
5. Violeta Mirchevska, *Behavior modeling by combining machine learning and domain knowledge*: doctoral dissertation, Ljubljana, 2013 (mentor Matjaž Gams; co-mentor Mitja Luštrek).
6. Bogdan Pogorelc, *Data-mining-based health monitoring of the elderly using motion-capture data*: doctoral dissertation, Ljubljana, 2013 (mentor Matjaž Gams).
7. Andrej Kariž, *Waste minimization in the production of sheet metal casings*: master's thesis, Nova Gorica, 2013 (mentor Bogdan Filipič).
8. Marko Perkon, *Developing information support for car rental in an automobile repair shop*: master's thesis, Nova Gorica, 2013 (mentor Bogdan Filipič).
9. Tomislav Štrukelj, *Introduction of new type of two-speed electric motor stator into production*: master's thesis, Nova Gorica, 2013 (mentor Bogdan Filipič).
10. Jernej Zupančič, *Centrality indices*: master's thesis, Ljubljana, 2013 (mentor Riste Škrekovski).

DEPARTMENT OF REACTOR ENGINEERING

R-4

The Department of Reactor Engineering is involved in basic and applied research in the fields of nuclear engineering and safety. Topics include the modelling of basic thermal-hydrodynamic phenomena, thermal-hydraulic safety analyses of design-basis and severe accidents, structural safety analyses and probabilistic safety assessments. Most research activities are part of international cooperation programs. The research results are incorporated in projects for industry and for the regulatory authorities, as well as in undergraduate and doctoral studies programmes.

Modelling of basic thermal-hydrodynamic phenomena

Research on turbulent heat transfer was continued. A theoretical analysis of a heated slab cooled with a turbulent flow on both sides was performed using Direct Numerical Simulation. The results predict a penetration of the turbulent temperature fluctuations into the solid wall. For a sufficiently thick slab, temperature fluctuations from both sides of the slab do not interfere. However, as the slab gets thinner, fluctuations from both sides interfere and tend to a finite value as the slab thickness limits towards zero. The research was related to the THINS project (7th European Commission Framework Programme) and might be relevant for next-generation fission reactors that will be cooled with liquid metals.

Simulations of turbulent flow in a horizontal fuel bundle with mixing vanes were continued (OECD/NEA benchmark), using an open-source code. Computational analyses were focused on improvements to the turbulence modelling and computational grid, and were verified with the MATIS-H experiment (Measurement and analysis of turbulent mixing in sub-channels – horizontal) that was performed at KAERI (Korea Atomic Energy Research Institute) in South Korea.

For the past few years, the department has been actively involved in the development of a helium-cooled divertor for the DEMO fusion reactor. Heat removal by multiple jet impingement is foreseen for divertor cooling. Turbulent flow structures that are generated in the area where the jets impinge on the cooled surface are crucial for effective cooling. The formation and propagation of the structures, and their influence on the local heat-transfer characteristics were analysed numerically by means of a Large Eddy Simulation, in cooperation with the Paul Scherrer Institute (Switzerland).

Research on numerical methods in fluid mechanics was continued as well. In the frame of the NURES SAFE project (7th EC FP), new theoretical models for interface capturing and sharpening within two-fluid models of two-phase flow were examined. The simulation of a simple air-water counter-current flow, related to so-called flooding in vertical pipes, was carried out. Detailed knowledge of basic physical mechanisms of the flooding phenomena in pipes is of particular interest for safety analyses of a loss-of-coolant accident in nuclear reactors.

Natural convection in a closed cavity was analysed with various versions of spectral schemes that are used to solve numerically the transport equations of fluid mechanics, as well as with the Lattice-Boltzmann method. Various runs were performed to test the accuracy of the numerical schemes and the efficiency of the parallelization on parallel computers.

Basic phenomena that might occur during a hypothetical severe accident in a nuclear power plant were investigated. A steam explosion is an energetic fuel-coolant interaction process, which may occur if, during an accident, the hot reactor-core melt comes into contact with coolant water. Steam explosions are an important nuclear safety issue because they can potentially jeopardize the primary system and the containment integrity of a nuclear plant. Within the SERENA project (OECD/NEA) and the SARNET2 network (7th EC FP), we continued simulations and analyses, using the European code MC3D, of steam explosion experiments performed in the KROTOS (Commissariat à l'Énergie Atomique - CEA, France) and TROI (KAERI) facilities. Based on the developed single-melt droplet-solidification model, fragmentation criteria for fuel-coolant interaction codes were established for various non-eutectic prototypic materials. Both single- and multiple-droplet size group modelling approaches were considered. The important influence of the metallic



Head:
Prof. Leon Cizelj

A new method for the assessment of the on-site power system reliability after an earthquake with a specific magnitude was developed.

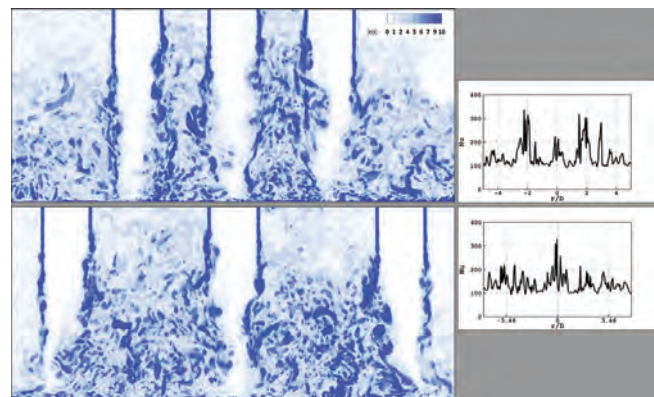


Figure 1: Large Eddy Simulation (LES) of multiple impinging jets: vortical structures (left) and profiles of the local heat-transfer coefficient at the cooled surface (right) are presented in two characteristic planes.

zirconium content in prototypic oxidic corium on the steam explosion energetics was analysed using SERENA and ZREX (Argonne National Laboratory, USA) experimental results. To explain the observed experimental behaviour,

Using Direct Numerical Simulation, we have analysed the penetration of temperature fluctuations into the interior of a hot slab cooled on both sides by flowing liquid.

the hydrogen film hypothesis was proposed. A comprehensive oxidation influence study was performed with the MC3D code, which supports the proposed hypothesis. Apart from that, the potential of strong vapour explosions during melt-sodium interaction was investigated as well.

In the field of modelling of atmosphere mixing in the containment, we have simulated the experiment NATHCO that was performed in the MISTRA

facility (CEA) within the SETH-2 project (OECD/NEA). The simulation successfully replicated the natural circulation in the MISTRA vessel, which was induced by gradual heating of the vessel walls. The influence of two different models of turbulence was also compared.

Thermal-hydraulic safety analyses

Stress tests, which had to be performed in European nuclear power plants after the accident at the Fukushima Daiichi (Japan) nuclear power plant in 2011, also required an evaluation of the consequences of the loss of safety functions due to station blackout (SBO). Therefore, long-term SBO analyses of a two-loop pressurized water reactor (PWR) were performed using the RELAP5/MOD3.3 computer code to evaluate the time before the water level reaches the top of the reactor core and the time of significant core heat-up. Different reactor coolant pump (RCP) seal leaks were assumed, using two main strategies: depressurization of the reactor coolant system (RCS) and water injection into RCS. The results suggest that for the expected magnitude of RCPs seal leaks in the selected two-loop PWR, the core uncover during the first seven days could be prevented by an available turbine-driven auxiliary pump (TD AFW) and manually depressurizing the RCS through the secondary side depressurization. In scenarios without TD AFW pumps, the core uncovers and heats up in less than one week.

The experiment on hydrogen combustion that was performed in 2012 in the HYKA A2 facility at the Karlsruhe Institute of Technology (Germany) was simulated with the lumped-parameter code ASTEC. The HYKA A2 facility is a cylindrical vessel with a volume of 240 m³. A hydrogen-steam-air mixture was ignited at the bottom of the vessel, which caused combustion and flame propagation in the vertical and radial directions. An international benchmark exercise for lumped-parameter codes was also organised, with contributions from RSE (Italy), UJD SR (Slovakia), NUBIKI (Hungary), LEI (Lithuania) and JSC Atomenergoproekt (Russia).

For the case of a spent-fuel-pit (SFP) accident, a calculation procedure was developed, which, based on monitoring of either the coolant level elevation, or leakage intensity, or dose rate on the edge of the SFP, assesses the pool integrity indirectly. Once the crack of the SFP has been characterized in terms of the size and the vertical location of the rupture, the procedure presents the necessary and possibly the only means for predicting the course of an extreme event. During the remediation of the damage, these data can be used for assigning the priorities, optimizing absorbed doses and eventually for anticipating the timely evacuation of the site.

Structural safety analyses

Recent research has been focused on the development of multiscale computational simulation tools for polycrystalline metallic materials. An advanced constitutive model of crystal plasticity is combined with random grain sizes and shapes. The data on crystal grains are retrieved either from experimental (e.g., X-ray diffraction contrast tomography) or analytical (e.g., Voronoi tessellation) methods. The loading of randomly shaped and oriented crystal grains with anisotropic properties results in highly inhomogeneous microscopic stress fields, which are estimated using the finite-element solver ABAQUS.

In 2013 we introduced and compared cohesive-element and cohesive-zone approaches to modelling the intergranular cracking on the grain level. The cohesive-surface approach proved to be simpler to implement, while the cohesive elements made the tracking of the damage initiation and evolution easier. In addition, the cohesive-surface approach proved to be numerically much more stable compared to cohesive elements. To alleviate the convergence issues, we developed an analytical expression for assessing the cohesive element response when using viscous regularization. The development of the simulation method benefits from our collaboration with the EC Joint Research Center in Petten (Netherlands).

We calibrated a crystal-plasticity finite-element model to describe the deformation behaviour of single-crystalline 316L stainless steel. This type of steel is an important structural material used for in-core components and pressure boundaries of light water reactors. Nine hardening

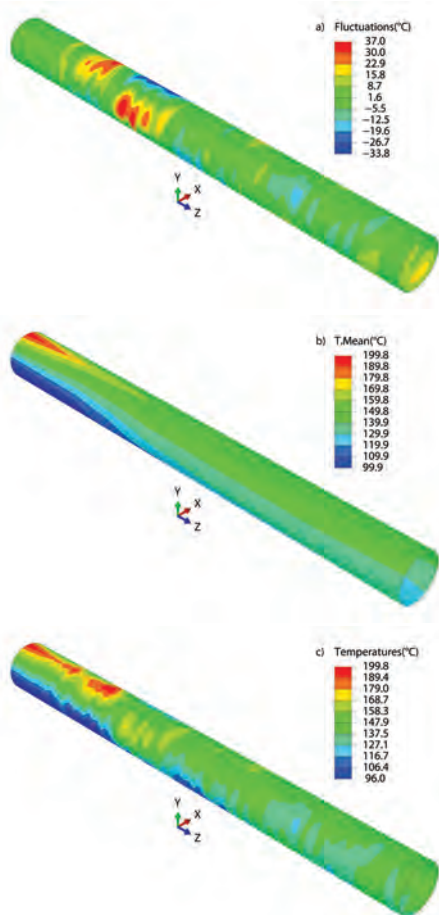


Figure 2: Fluid temperature fields at the inner pipe wall emulating thermal loads downstream of a T-junction for a turbulent mixing of hotter (200°C) and colder (100°C) water: a) calculated temperature fluctuations, b) provided mean temperatures, c) final temperatures.

parameters were identified by fitting the calculated stress-strain curves to corresponding measurements in three tensile directions. A very good agreement with the measurements was found in all directions.

Regarding thermal fatigue research, a new approach was developed for the fast and reliable generation of random surface thermal loads which relies on the approximation of fluid temperature fluctuations with the linear superposition of plane waves. The approach employs fluid temperature statistics, such as the mean and variance, from experimental or computational simulations results. The approach was applied to fatigue analyses of pipes.

We have also addressed the structural integrity of PWR fuel rods by employing the hydration effects of Zircaloy-4 cladding tubes during in-service operation. A finite-element model of the fuel rod was developed for different hydride blister morphologies. A damage model for the cladding was constructed and analysed in comparison with experimental results.

Part of the work was related to international research projects. Within the MULTIMETAL (7th EU FP) project, we performed finite-element calculations of the fracture toughness for several pre-cracked specimen designs. In the bilateral project with CEA, the realistic stainless-steel wire model was modified to suit the CEA finite-element code Castem.

Probabilistic safety assessment

A new method for the assessment of the on-site power system's reliability after an earthquake with a given magnitude was developed. The new method considers the design features and functional dependencies within the on-site power system and the seismic fragility of the constituting elements.

The obtained results show the importance of the on-site power system's reliability in general and battery supported section of the Class 1E power system in particular for the safety of the nuclear power plant. A high level of reliability is obtained for the Class 1E and Non-1E power system during normal operation and safe shutdown during an earthquake. The calculated

results show a high level of reliability of a Class 1E power system after an earthquake with peak ground acceleration equal to the one measured at the Fukushima Daiichi (Japan) nuclear power plant during the 2011 earthquake. A revision of the current guideline for assessment of the acceptable station blackout duration capability was recommended, considering the results of the analysis and identified deficiencies in the current guideline.

A new model for the optimal generation dispatch of a power system was proposed. The model extends the classical combined economic-environmental power dispatch considering the availability of the generating units as the third objective. The unavailability of power generation is defined as the risk index and is considered to be a function of the generating units' power level. The results show an increase of the availability of power generation followed by a small increase in the fuel costs and the gaseous emission.

The Slovenian power system was analysed using a multi-objective generation scheduling model. The model considers three objective functions: fuel costs, emissions of gaseous pollutants and unavailability of power generation. First, the conventional generation scheduling is solved taking into consideration only the fuel costs. Second, the generation scheduling is solved as a combined risk-economic-environmental optimization problem that takes into consideration all the above-mentioned objectives. The results show that smart scheduling of power generation may decrease the emissions and increase the availability of power generation in the Slovenian power system.

Technical cooperation, consulting services and education

Reactor Engineering Department researchers also cooperated in projects for industry. As an authorized institution for radiation and nuclear safety, and in the framework of regular Krško nuclear power plant (NPP) activities for maintenance and improvements to nuclear safety, we performed an independent expertise of the regular Krško NPP outage. During the outage, we performed inspection activities on safety structures, systems and components. A report with proposals for safety improvements was prepared.

Apart from that, the Reactor Engineering Department was contacted by the Krško NPP to perform a part of the review in the framework of the 2nd Periodic Safety Review (PSR). The PSR is a comprehensive safety review of all the important aspects of safety and is carried out at regular intervals (typically 10 years). The PSR is subdivided into 14 safety factors. We performed a review of three safety factors: deterministic safety analyses, probabilistic safety analyses and hazard analyses. Separate reports on each of the safety factors were prepared with proposals for safety improvements.

Members of the department are also actively involved in nuclear engineering under-graduate, master and doctoral studies at the Faculty of Mathematics and Physics at the University of Ljubljana. The programmes are associated with the European Nuclear Education Network (ENEN) and the European project ENEN-III.

A new approach was developed for the fast and reliable generation of continuous temperature fields that emulate thermal loads in T-junction piping due to turbulent fluid mixing.

Organization of conferences, congresses and meetings

1. International conference NENE2013 – “22nd International Conference Nuclear Energy for New Europe”, Bled, Slovenia, 9. 9.–12. 9. 2013
2. Regional meeting of NEWLANCER, Ljubljana, Slovenia, 15.–17. 4. 2013
3. Autumn meeting of users and administrators SLING, Ljubljana (JSI Reactor Center), Slovenia, 13. 11. 2013

INTERNATIONAL PROJECTS

1. 7FP - SARNET2; Network of Excellence for a Sustainable Integration of European Research on Severe Accident Phenomenology and Management - Phase 2
European Commission
Dr. Matjaž Leskovar
2. 7FP - EURATOM - ENEN-III; European Nuclear Education Network Training Schemes
European Commission
Prof. Leon Cizelj
3. 7FP - EURATOM - THINS; Thermal-hydraulics of Innovative Nuclear Systems
European Commission
Prof. Iztok Tiselj
4. 7FP - EURATOM - TRASNUSAFE; Training Scheme on Nuclear Safety Culture
European Commission
Prof. Borut Mavko
5. 7FP - NEWLANCER; New MS Linking for an Advanced Cohesion in Euratom Research
European Commission
Prof. Leon Cizelj
6. 7FP - EURATOM; MULTIMETAL; Structural Performance of Multi-metal Component
European Commission
Prof. Leon Cizelj
7. 7FP - NURESAFE; Nuclear Reactor Safety Simulation Platform
European Commission
Dr. Boštjan Končar
8. 7FP - CESAM; Code for European Severe Accident Management
European Commission
Asst. Prof. Ivo Kljenak
9. 7FP - ASAMPESA_E; Advanced Safety Assessment: Extended PSA
European Commission
Dr. Andrija Volkanovski
10. 7FP - ARCADIA; Assessment of Regional Capabilities for New Reactors Development through an Integrated Approach
European Commission
Prof. Leon Cizelj
11. 7FP - EURATOM; Public Information; Research Unit - Administration and Services - RU-FU; 3211-08-000102, FU07-CT-2007-00065
Ministry of Education, Science and Sport
Dr. Boštjan Končar
12. 7FP - EURATOM, MHEST Association; Divertor High Flux Helium Cooling - 4.5.1. - FU, FU-07-CT-2007-00065
Ministry of Education, Science and Sport
Dr. Boštjan Končar
13. 7FP - MHEST Association EURATOM, 4.10.1.-FU; TH Analyses of DEMO Blanket
Ministry of Education, Science and Sport
Dr. Boštjan Končar
14. 7FP - EURATOM-MHEST; WP13-DAS-02-T12-01/MESCS/PS, Helium Cooled Divertor Design and Fabrication Analysis
Ministry of Education, Science and Sport
Dr. Boštjan Končar
15. Training and Tutoring for Experts of the NRAs and their TSOs for Developing and Strengthening their Regulatory and Technical Capabilities - INSC Project MC.03/10 - LOT 1: Training and Tutoring for Nuclear Regulatory Authorities and their TSO's ITER-consult Srl
Prof. Leon Cizelj
16. Investigation of Flow Boiling Mechanisms in Nuclear Engineering
Slovenian Research Agency
Dr. Boštjan Končar

17. European Nuclear Society; ENS Board of Directors; ENS High Scientific Council Meeting
Slovenian Research Agency
Prof. Leon Cizelj
18. SNETP - Sustainable Nuclear Energy Technology Platform; SNETP General Assembly
Slovenian Research Agency
Prof. Leon Cizelj
19. Application and Validation of Multiscale Method for Two-phase Flow Analyses in Nuclear Reactors
Slovenian Research Agency
Dr. Boštjan Končar
20. Simulations of Atmosphere Stratification Breakup Experiments with Lumped-parameter Codes
Slovenian Research Agency
Asst. Prof. Ivo Kljenak
21. Comprehensive and Reliable Prediction of LWR's Internals Mechanical Behavior Based on Microstructure-informed Modeling
Slovenian Research Agency
Dr. Samir El Shawish
22. Influence of Oxidation and Large Solidification Temperature Range of Fuel Coolant Interaction
Slovenian Research Agency
Dr. Matjaž Leskovar

RESEARCH PROGRAM

1. Reactor engineering
Prof. Leon Cizelj

R&D GRANTS AND CONTRACTS

1. Experiment and Simulation of Hydrogen Combustion in Nuclear Power Plant Containment Experimental Facility
Prof. Borut Mavko
2. Development of Methods and Models for Simulation of Thermal-Hydraulic Phenomena in Innovative Nuclear Reactors
Prof. Iztok Tiselj
3. Steam Explosions in Sodium Cooled Fast Reactors
Dr. Mitja Uršič
4. Code Applications and Maintenance Program (CAMP); Thermal-Hydraulic Code Applications and Maintenance
Dr. Andrej Prošek

NEW CONTRACTS

1. Cooperation in an International CAMP Program
Krško Nuclear Power Plant
Dr. Andrej Prošek
2. Expert Opinion in Krško NPP Tests and Repairs During Refuelling 2013
Milan Vidmar Electrotechnical Institute
Ljubo Fabjan, M. Sc.

VISITORS FROM ABROAD

1. Prof. Hiroshige Kikura, Tokyo Institute of Technology, Department of Nuclear Engineering, Tokyo, Japan, 25. 2. 2013
2. Dr. Imre F. Barna, Centre for Energy Research of the Hungarian Academy of Sciences, Budapest, Hungary, 26.–30. 8. 2013
3. Ricard Mas Fillol, Universitat Politècnica de Catalunya (UPC), Barcelona, Spain, 18. 2.–30. 9. 2013
4. Prof. Grzegorz Wrochna, National Centre for Nuclear Research, Swierk, Poland, 13. 9. 2013
5. Dejan Židan, M. Sc., Ministry of Agriculture and the Environment, Ljubljana, Slovenia, 13. 8. 2013
6. Prof. Ivo Roghair (with students), Eindhoven University of Technology, T.S.V. Jan Pieter Minckelers, Eindhoven, Netherlands, 7. 11. 2013

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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Ovidiu-Adrian Berar, Andrej Prošek, Borut Mavko, "RELAP5 and TRACE assessment of the Achilles natural reflood experiment", *Nucl. Eng. Des.*, vol. 261, pp. 306-316, avg. 2013.
2. Samir El Shawish, Leon Cizelj, Igor Simonovski, "Modeling grain boundaries in polycrystals using cohesive elements: Qualitative and quantitative analysis", *Nucl. Eng. Des.*, vol. 261, pp. 371-381, avg. 2013.
3. Oriol Costa Garrido, Leon Cizelj, Samir El Shawish, "The role of the axial heat fluxes in the thermal fatigue assessment of piping", *Nucl. Eng. Des.*, vol. 261, pp. 382-393, avg. 2013.
4. Blaže Gjorgiev, Marko Čepin, "A multi-objective optimization based solution for the combined economic-environmental power dispatch problem", *Eng. appl. artif. intell.*, vol. 26, no. 1, pp. 417-429, 2013.
5. Blaže Gjorgiev, Marko Čepin, Andrija Volkanovski, Duško Kančev, "Multi-objective power-generation scheduling: Slovenian power system case study: elektroenergetski sistem Slovenije", *Elektrotehniški vestnik*, vol. 80, no. 5, pp. 222-228, 2013.
6. Blaže Gjorgiev, Duško Kančev, Marko Čepin, "A new model for optimal generation scheduling of power system considering generation units availability", *Electr. power energy syst.*, vol. 47, no. 1, pp. 129-139, 2013.
7. Seong-Wan Hong, Pascal Piluso, Matjaž Leskovar, "Status of the OECD-SERENA project for the resolution of ex-vessel steam explosion risks", *J. energy power eng.*, vol. 7, no. 3, pp. 423-431, 2013.
8. Boštjan Končar, Martin Draksler, Prachai Norajitra, "Design and cooling of the edge segments of the DEMO divertor target plates", In: *Proceedings of the 27th Symposium on Fusion Technology, SOFT-27, Liège, Belgium, September 24-28, 2012, Fusion eng. des.*, vol. 88, no. 6/10, pp. 1831-1835, 2013.
9. Anja Kostevšek, Leon Cizelj, Janez Petek, Aleksandra Pivec, "A novel concept for a renewable network within municipal energy systems", *Renew. energy*, vol. 60, pp. 79-87, dec. 2013.
10. Samo Košmrlj, Boštjan Končar, "Simulating cyclic high heat flux loading of divertor cooling finger mock-up", *Nucl. Eng. Des.*, vol. 261, pp. 317-325, avg. 2013.
11. Andrej Prošek, Leon Cizelj, "Long-term station blackout accident analyses of a PWR with RELAP5/MOD3.3", *Sci. Technol. Nucl. Install.*, vol. 2013, 2013.
12. Igor Simonovski, Leon Cizelj, "Cohesive element approach to grain level modelling of intergranular cracking", *Eng. fract. mech.*, vol. 110, pp. 364-377, sep. 2013.
13. Igor Simonovski, Leon Cizelj, Oriol Costa Garrido, "The influence of the grain boundary strength on the macroscopic properties of a polycrystalline aggregate", *Nucl. Eng. Des.*, vol. 261, pp. 362-370, avg. 2013.
14. Iztok Tiselj, Jure Oder, Leon Cizelj, "Double-sided cooling of heated slab: conjugate heat transfer DNS", *Int. j. heat mass transfer*, vol. 66, pp. 781-790, nov. 2013.

15. Andrija Volkanovski, "On-site power system reliability of a nuclear power plant after the earthquake", *Kerntechnik (1987)*, vol. 78, no. 2, pp. 99-112, 2013.

16. Andrija Volkanovski, Andrej Prošek, "Extension of station blackout coping capability and implications on nuclear safety", *Nucl. Eng. Des.*, vol. 255, pp. 16-27, feb. 2013.

PUBLISHED CONFERENCE CONTRIBUTION (INVITED LECTURE)

1. Andrej Prošek, Marko Matkovič, "Status of CAMP activities in Slovenia", In: *Proceedings*, Fall 2013 CAMP Meeting, November 6 - 8, 2013, Washington, DC, USA, [S. l., s. n.], 2013, 27 pp.

PUBLISHED CONFERENCE CONTRIBUTION

1. A. Bentaib *et al.* (15 authors), "SARNET hydrogen deflagration benchmarks: main outcomes and conclusions", In: *ERMSAR 2013*, 6th European Review Meeting on Severe Accident Research, October 2-4, 2013, Avignon, France, [S. l.], SARNET, 2013, 18 pp.
2. Ovidiu-Adrian Berar, Andrej Prošek, Borut Mavko, "TRACE code analysis of a two-loop PWR coolant mixing in the reactor pressure vessel", In: *Proceedings*, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 231-1-231-8.
3. Matej Bogataj, Samir El Shawish, Leon Cizelj, "Soft missile impact into reinforced concrete wall: comparing simulations to experiments", In: *Proceedings*, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 313-1-313-7.
4. Zhongxiang Chen, Leon Cizelj, Mitja Uršič, "The simulated damage of zircaloy fuel cladding tubes with brittle hydride blisters", In: *Proceedings*, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 302-1-302-8.
5. Leon Cizelj, Ivo Kljenak, Iztok Tiselj, "Revisiting the Slovenian Ph. D. theses in nuclear engineering: Is use-inspired basic research an appropriate goal?", In: *NEStet 2013, Nuclear Education and Training: Transactions, Madrid 17-21 November 2013*, Brussels, European Nuclear Society, 2013, pp. 120-126.
6. Martin Draksler, Boštjan Končar, Leon Cizelj, Bojan Ničeno, "Flow and heat transfer characteristics of multiple impinging jets: Large Eddy Simulation", In: *Proceedings*, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12, Leon Cizelj,

- ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 1412-1-1412-9.
7. Samir El Shawish, Matej Bogataj, Leon Cizelj, "Crystal plasticity model calibration for 316L stainless steel single crystals during deformation", In: *Computational Plasticity XII: proceedings of the XII International Conference on Computational Plasticity - Fundamentals and Applications, COMPLAST XII, Barcelona, Spain 3 - 5 September 2013*, Eugenio Oñate, ed., Barcelona, International Center for Numerical Methods in Engineering (CIMNE), 2013, pp. 811-821.
 8. Samir El Shawish, Leon Cizelj, Igor Simonovski, "Evolution of crystal orientations in plastically deformed steels: role of constitutive models used in finite element simulations", In: *ICONE21, 21st International Conference on Nuclear Engineering*, July 29 - August 2, 2013, Chengdu, China, [S. l.], ASME = American Society of Mechanical Engineers, cop. 2013, 8 pp.
 9. Oriol Costa Garrido, Samir El Shawish, Leon Cizelj, "Thermal stresses in pipes caused by randomly generated two-dimensional temperature fluctuations", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 316-1-316-9.
 10. Blaže Gjorgiev, Duško Kančev, Andrija Volkanovski, Marko Čepin, "Power system unit commitment: probabilistic modeling of generating capacities availability", In: *Safety, reliability and risk analysis: beyond the horizon*, European Safety and Reliability Conference, ESREL 2013, Amsterdam, The Netherlands, 29 September - 2 October 2013, R. D. J. M. Steenbergen, ed., Boca Raton [etc.], CRC Press, 2013, pp. 2153-2160.
 11. Blaže Gjorgiev, Andrija Volkanovski, Duško Kančev, Marko Čepin, Ljubo Fabjan, "Independent off-site water storage connection to nuclear power plant", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 502-1-502-8.
 12. Romain Henry, Iztok Tiselj, "Computational fluid dynamic model of TRIGA Mark II reactor", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 209-1-209-9.
 13. Duško Kančev, Blaže Gjorgiev, Andrija Volkanovski, "Sensitivity study of a new model for assessing time-dependent risk in ageing NPP", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 504-1-504-8.
 14. St. Kelm *et al.* (26 authors), "Generic containment: detailed comparison of containment simulations performed on plant scale", In: *ERMSAR 2013*, 6th European Review Meeting on Severe Accident Research, October 2-4, 2013, Avignon, France, [S. l.], SARNET, 2013, 14 pp.
 15. Ivo Kljenak, M. Kuznetsov, Gerold Stern, Borut Mavko, "Upward flame propagation experiment of hydrogen combustion", In: *ERMSAR 2013*, 6th European Review Meeting on Severe Accident Research, October 2-4, 2013, Avignon, France, [S. l.], SARNET, 2013, 9 pp.
 16. Ivo Kljenak, Mikhail Kuznetsov, Giovanni Manzini, Pál Kostka, Lubica Kubišova, Mantas Povilaitis, "Simulation of hydrogen deflagration experiment Benchmark exercise with lumped-parameter codes", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 415-1-415-8.
 17. Anja Kostevšek, Leon Cizelj, Janez Petek, Lidija Čuček, Petar Varbanov, Jiri Klemeš, Aleksandra Pivec, "Use of renewables in rural municipalities' integrated energy systems", In: *PRES'13, the 16th International Conference on Process Integration, Modelling, and Optimisation for Energy Saving and Pollution Reduction, 29 September - 2 October, 2013, Rhodes, Greece*, (Chemical engineering transactions, vol. 35, 2013), Petar Varbanov, ed., Milano, AIDIC, 2013, vol. 35, pp. 895-900, 2013.
 18. Anja Kostevšek, Leon Cizelj, Janez Petek, Jiri Klemeš, Petar Varbanov, Lidija Čuček, Aleksandra Pivec, "Locally integrated energy sectors - integration of Ormož district heating system using renewable energy sources", In: *Digital proceedings*, (CD Proceedings (Dubrovnik Conference on sustainable development of energy, water and environment systems)), 8th Conference on sustainable development of energy, water and environment systems, September 22-27, 2013, Dubrovnik, Marko Ban, ed., Neven Duić, ed., Zvonimir Guzović, ed., Dubrovnik, 2013, 9 pp.
 19. Matjaž Leskovar, "Analysis of ex-vessel steam explosion in 3-D", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 401-1-401-9.
 20. Matjaž Leskovar, "PWR ex-vessel steam explosion analysis in 3-D", In: *Annual Meeting of the American Nuclear Society, June 16-20, 2013, Atlanta, Georgia*, (Transactions of the American Nuclear Society, Vol. 108, 2013), New York, Academic Press, 2013, vol. 108, pp. 1061-1062, 2013.
 21. Renaud Meignen *et al.* (14 authors), "Status of steam explosion understanding and modelling", In: *ERMSAR 2013*, 6th European Review Meeting on Severe Accident Research, October 2-4, 2013, Avignon, France, [S. l.], SARNET, 2013, 13 pp.
 22. Blaž Mikuž, Iztok Tiselj, Matthias Beyer, "1D two-fluid model simulations of flashing flows in TOPFLOW facility", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 221-1-221-8.
 23. Prachai Norajitra, W. Basuki, Boštjan Končar, L. Spatafora, "He-cooled divertor: study on low-temperature design using Ta alloy as thimble material", In: *SOFE 25*, 25th Symposium on Fusion Engineering, June 10-14, 2013, San Francisco, California, Denver, IEEE = Institute of Electrical and Electronics Engineers, 5 pp.
 24. Jure Oder, Iztok Tiselj, "Chebyshev collocation benchmark for natural convection flow in differentially heated cavity", In: *Proceedings of the 11th International Conference on Numerical Analysis and Applied Mathematics, ICNAAM 2013, 21-27 September 2013, Rhodes, Greece*, (AIP conference proceedings, vol. 1558, 2013), New York, American Institute of Physics, 2013, vol. 1558, pp. 103-106, 2013.
 25. Jure Oder, Iztok Tiselj, "Spectral benchmark for natural convection flow in a tall differentially heated cavity", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 227-1-227-8.
 26. Andrej Prošek, Ovidiu-Adrian Berar, "Advanced presentation of Bethsy 6.2tc test calculations with TRACE", In: *NURETH-15*, 15th International Meeting on Nuclear Reactor Thermal Hydraulics, May 12-17, 2013, Pisa, Italy, [S. l.], American Nuclear Society, 2013, 12 pp.
 27. Andrej Prošek, Leon Cizelj, "Long term station blackout analyses of two loop PWR using RELAP5/MOD3.3", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 201-1-201-8.
 28. Ferry Roelofs *et al.* (14 authors), "European developments in single phase turbulence for innovative reactors", In: *NURETH-15*, 15th International Meeting on Nuclear Reactor Thermal Hydraulics, May 12-17, 2013, Pisa, Italy, [S. l.], American Nuclear Society, 2013, 15 pp.
 29. Igor Simonovski, Leon Cizelj, "Cohesive zone modeling of intergranular cracking in polycrystalline aggregates", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 306-1-306-8.
 30. Igor Simonovski, Leon Cizelj, Gangadhar Machina, Mihaela Irina Uplaznik, "Modeling intergranular cracking in polycrystalline aggregates: explicit account for grain boundaries with cohesive zone approach", In: *SMIRT 22*, 2nd International Conference on Structural Mechanics in Reactor Technology, 18-23 August, San Francisco, California, USA, [S. l.], AASMiRT = American Association for Structural Mechanics in Reactor Technology, 2013, 10 pp.
 31. Matej Tekavčič, Boštjan Končar, Ivo Kljenak, "Analysis of gas-liquid churn flow in a vertical pipe", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013*, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 219-1-219-8.
 32. Matej Tekavčič, Boštjan Končar, Ivo Kljenak, "Simulation of counter-current gas-liquid churn flow", In: *ASME 2013 Summer Heat Transfer Conference, July 14-19, 2013, Minneapolis, MN*, [S. l.], ASME = American Society of Mechanical Engineers, 2013, 8 pp.
 33. Iztok Tiselj, "Computational domain of DNS simulations of liquid sodium", In: *NURETH-15*, 15th International Meeting on Nuclear Reactor Thermal Hydraulics, May 12-17, 2013, Pisa, Italy, [S. l.], American Nuclear Society, 2013, 13 pp.
 34. Iztok Tiselj, "Temperature fluctuations inside the infinite heated slab cooled with turbulent flow from both sides", In: *ASME 2013 Fluids Engineering Division Summer Meeting, July 7-11, 2013, Incline Village, Nevada, US*, [S. l.], ASME = American Society of Mechanical Engineers, 2013, 7 pp.

35. Andrija Volkanovski, "PSA integral importance measures", In: *PSA 2013, International Topical Meeting on Probabilistic Safety Assessment and Analysis*, September 22-27, 2013, Columbia, South Carolina, USA, [S. l.], American Nuclear Society, 2013, 13 pp.
36. Andrija Volkanovski, Blaže Gjorgiev, Duško Kančev, "Component unavailability uncertainty and the safety systems unavailability", In: *Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled*, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 503-1-503-8.
37. Andrija Volkanovski, Duško Kančev, Blaže Gjorgiev, "Uncertainty distributions and probabilistic safety analysis", In: *Safety, reliability and risk analysis: beyond the horizon*, European Safety and Reliability Conference, ESREL 2013, Amsterdam, The Netherlands, 29 September - 2 October 2013, R. D. J. M. Steenbergen, ed., Boca Raton [etc.], CRC Press, 2013, pp. 3369-3377.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Andrej Prošek, Marko Čepin, "Deterministic safety analyses for human reliability analysis", In: *Artificial intelligence and hybrid systems*, Claudio

Rocha, ed., Fernando Akune, ed., Ahmed El-Shafie, ed., Hong Kong, IConcept Press, 2013, pp. 73-109.

PROFESSIONAL MONOGRAPH

1. Alain Chevalier *et al.* (30 authors), *Strategic research and innovation agenda: February 2013*, (SNETP = Sustainable Nuclear Energy Technology Platform), [S. l., s. n.], 2013.

MENTORING

1. Blaže Gjorgiev, *Optimal generation schedule of nuclear and other power plants with application of genetic algorithms*: doctoral dissertation, Ljubljana, 2013 (mentor Marko Čepin).
2. Ricard Mas Fillol, *Experimental test apparatus for heat transfer and fluid flow studies in multi-phase systems*: master's thesis, Ljubljana, 2013 (mentor Ivo Kljenak; co-mentor Marko Matkovič).

REACTOR INFRASTRUCTURE CENTRE

RIC

The Reactor Infrastructure Centre incorporates a research reactor TRIGA Mark II Reactor and a Hot Cells Facility. The reactor, operating since 1966, is used for neutron research, training and producing radioactive isotopes. A detailed technical description of the reactor is available at <http://www.rcp.ijs.si/~ric/>. The Hot Cells Facility is used for the treatment and handling of radioactive materials and radioactive waste within research and applicative projects. In addition, it is used for performing measurements within the regular radiological monitoring of the reactor.



Head:
Prof. Borut Smodiš

Besides operating and maintaining the reactor, the members of the reactor staff participate in other activities requiring specialists skilled in work with sources of radiation and in reactor technology, such as the servicing of industrial radioactive sources and surveillance of the fuel management in NPP Krško.

In 2013 the reactor operated for 136 days. Altogether, 825 samples were irradiated in the rotary specimen rack and 16 in the pneumatic transfer system. There were no serious operational problems or events influencing nuclear or radiation safety. The reactor operators were performing regular maintenance inspections and activities according to the annual plan.

In the Hot Cells Facility the activities were mostly performed by the Department of Environmental Sciences and the Radiation Protection Unit. The IJS staff performed training in radiochemistry and radioactivity measurements for practitioners from countries eligible under the JRC Enlargement & Integration policy. The treatment and conditioning of low and intermediate radioactive waste for subsequent storage in the central storage for radioactive waste was continuously performed together with the Slovenian Agency for Radioactive Waste Management (ARAO).

The reactor was mainly operated for the needs of the Jožef Stefan Institute's Nuclear Training Centre, for educational purposes (Faculty of Mathematics and Physics, University of Ljubljana and Faculty for Energy, University of Maribor) and research departments: Environmental Sciences, Reactor Physics and Experimental Particle Physics.

The reactor was used for the following research:

- Reactor physics and neutronics,
- Activation analysis,
- Research on radiation damage of semiconductors,
- Neutron dosimetry and spectrometry,
- Neutron radiography,
- Activation of materials, nuclear waste and decommissioning,
- Irradiation of materials for fusion reactors,
- Irradiation of electronic and medical components,
- Development and testing of new detectors,
- Development of new methods for measuring power profiles, neutron spectra, etc.,
- Verification and validation of methods for calculating the transport of neutrons, photons and electrons,
- Development of educational tools in reactor physics.

The TRIGA reactor participates in the FP7 AIDA (Advanced Infrastructures for Detectors and Accelerators) project that brings together advanced European infrastructures for future particle-physics experiments.

Within the frame of the "Experimental Verification of Kinetic Parameters of the TRIGA Reactor and the Upgrade of the Digital Meter of Reactivity" some experiments we conducted.

The project "Thermal neutron irradiation testing of NI PXI and cRIO products" together with National Instruments and ITER organization including the irradiation and testing of electronic instruments was brought to the end.

Within the international collaboration with the CEA, France, we tested the resistance of polyethylene capsules to thermal neutrons (project Design of an irradiation device for FT-TIMS method at the JSI TRIGA Mark II reactor) and performed preliminary measurements of the fission and ionisation chambers' response (project name: experimental verification of flux form factors and qualification of wide range neutron instrumentation).

In collaboration with the reactor physics division and CEA France a series of experiments were performed in order to determine the kinetic parameters of the reactor. This was the first time the measurements were performed with four fission chambers simultaneously. In addition, the new CEA developed system, called SPECTRON, was tested. Within the framework of this project the control rod worth measurement methods were improved. In another

CEA project the IRDF dosimetry library was tested by the reactor physics division and CEA. The calculations were compared against activation measurements at the TRIGA reactor in order to accurately determine the neutron spectra and irradiation channels.

The projects within the framework of the IAEA Technical Coordination Programme entitled "Carrying out a Feasibility Study and Installing the Thermal Neutron Driven 14 MeV Neutron Converter into the TRIGA Research Reactor" and the Installation of DT converter of neutrons in the TRIGA reactor" was continued.

Within the framework of the contract "Irradiation and Analysis for Si samples" with the Institute of Radiation Problems of AzNAS, Azerbaijan, various samples were irradiated in the TRIGA reactor and analysed in cooperation with some JSI departments. The project will continue in 2014.



Figure 1: Last year we had bubbles in the reactor, this year we have a reactor inside the bubbles.

The collaboration with INMEDICA, Slovenian Device Incubator for Medical Systems and Treatments was established, in the frame of which medical equipment is irradiated and the changes after irradiation are observed.

Practical exercises in reactor physics and kinetics for the students of physics at the University of Ljubljana were performed. Some of the exercises were performed for the first time in the history of the reactor.

The work on the Periodic Safety Report, that started in 2011, continued. The reactor operators took part at the outage of NPP Krško.

Before the reactor start-up at the NPP Krško, preparations and tests to conduct physical tests took place at the TRIGA reactor.

The reactor operators supported the researchers by performing the operations and services for which the researchers are not qualified and authorized, such as operating the reactor, performing irradiations and manipulating radioactive samples.

The research results were published in approximately 20 scientific papers. Seven young researchers performed their research at the reactor.

In November 2012 an IAEA INSARR mission was conducted. The objective of the mission was to review the operational safety of the reactor, including reactor management and regulatory supervision, Safety Analysis Report, safety analyses, Operational Limits and Conditions, conduct of operations, maintenance, training and qualifications of the operating personnel, utilization and modifications, operational radiation protection and waste management, emergency planning, quality assurance and decommissioning plan. The work on recommended issues was carried out in 2013 and continued in 2014.

In 2013 the following international course in the field of the safety of research reactors was performed:

1. TJET14: Nuclear Power Plant Technology, ICJT, 5.11.-2012 - 5.4.2013, 22 participants.

Practical exercises in reactor physics and kinetics for the students of physics at the University of Ljubljana were performed. The postgraduate students of nuclear engineering attended some of these exercises as well. For these purposes the reactor operated for approximately 2 months. The reactor was also used for practical exercises within the training program of the NPP Krško reactor operators. The exercises were prepared and carried out by the reactor personnel in co-operation with the Nuclear Training Centre and the Department of Reactor Physics.

In 2013, there were more than 50 short group visits to the reactor. The visitors were mainly foreign scientists, students and more than 33 groups of school children. The total number was more than 900.

INTERNATIONAL PROJECTS

1. Reports on Thermal Neutron Induced SEU Susceptibility of PX1e and cRIO Fast Controller Components
ITER Organization
Dr. Luka Snoj
2. Training in Radiochemistry and Radioactivity Measurements for Practitioners from Countries Eligible under the JRC Enlargement & Integration Policy
Institute for Reference Materials and Measurements
Prof. Borut Smodiš
3. Feasibility Study and Installation of Thermal Neutron Driven 14 MeV Neutron Converter into the TRIGA Research Reactor
IAEA - International Atomic Energy Agency
Dr. Luka Snoj
4. NATO SPS.EAP.SFP 984524; Radioactive and Heavy Metal Waste Tailings - Risk Reduction in Fergana Valley, Kyrgyz Republic
NATO - North Atlantic Treaty Organisation
Prof. Peter Stegnar

5. Automation of a Pneumatic Transport System for Neutron Activation Analysis
IAEA - International Atomic Energy Agency
Prof. Borut Smodiš
6. Training Fee for Ms Ilona Matveyeva, (Kazakhstan), 1. 6.-29. 8. 2013
ICTP - Centro Internazionale di Fisica Teorica
Prof. Borut Smodiš

R&D GRANTS AND CONTRACTS

1. Calculations to Support Neutron Monitor Calibration - JET Fusion Reactor Example Case
Dr. Luka Snoj
2. Small Services in Year 2013
Foreign Clients
Dr. Luka Snoj
3. Irradiation and Analysis of Si Samples
Anže Jazbec, B. Sc.

NEW CONTRACT

1. Treatment and Conditioning of Radioactive Waste for Storage
ARAO
Prof. Borut Smodiš

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2. Dr. Luka Snoj

Postgraduate

3. Anže Jazbec, B. Sc.

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8. Sebastjan Rupnik, B. Sc.

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. JET EFDA Contributors, M. P. Albuquerque *et al.*, "A 10000-image-per-second parallel algorithm for real-time detection of MARFES on JET", *IEEE trans. plasma sci.*, iss. 2, vol. 41, pp. 341-349, 2013.
2. JET EFDA Contributors, B. Baiocchi *et al.*, "Discriminating the role of rotation and its gradient in determining ion stiffness mitigation in JET", *Plasma phys. control. fusion*, iss. 2, vol. 55, pp. 025010-1-025010-7, 2013.
3. JET EFDA Contributors, B. Cannas *et al.*, "Manifold learning to interpret JET high-dimensional operational space", *Plasma phys. control. fusion*, no. 4, vol. 55, pp. 045006-1-045006-11, 2013.
4. JET EFDA Contributors, D. Dodt *et al.*, "Improved framework for the maintenance of the JET intershot analysis chain", *Fusion eng. des.*, vol. 88, no. 2, pp. 79-84, 2013.
5. JET EFDA Contributors, J. Eriksson *et al.*, "Finite Larmor radii effects in fast ion measurements with neutron emission spectrometry", *Plasma phys. control. fusion*, iss. 1, vol. 55, pp. 015008-1-015008-9, 2013.
6. JET EFDA Contributors, G. Hommen *et al.*, "A fast, magnetics-free flux surface estimation and q-profile reconstruction algorithm for feedback control of plasma profiles", *Plasma phys. control. fusion*, iss. 2, vol. 55, pp. 025007-1-025007-11, 2013.
7. Anže Jazbec, Gašper Žerovnik, Luka Snoj, Andrej Trkov, "Analysis of tritium production in TRIGA Mark II reactor at JSI for the needs of fusion research reactors", *Atw, Int. Z. Kernenerg.*, iss. 12, vol. 58, pp. 701-705, 2013.
8. JET EFDA Contributors, K.D. Lawson *et al.*, "The effect of ionization on the populations of excited levels of C IV and C V in tokamak edge plasmas", *J. phys., B At. mol. opt. phys.*, vol. 46, no. 3, pp. 035701-1-035701-18, 2013.
9. Igor Lengar, Luka Snoj, "Benchmark evaluation of interacting aluminum cylinders containing uranyl fluoride solution", In: Special section NENE 2011, 20th international conference "Nuclear Energy for New Europe" (NENE 2011), Bovec, Slovenija, Sept.12. - 15. 2011, *Nucl. Eng. Des.*, vol. 261, pp. 232-237, 2013.
10. JET EFDA Contributors, M. J. Lopez *et al.*, "Integration and validation of a disruption predictor simulator in JET", *Fusion science and technology*, iss. 1, vol. 63, pp. 26-33, 2013.
11. Branko Petrinc, Marko Štrok, Zdenko Franić, Borut Smodiš, Dijana Pavičić Hamer, "Radionuclides in the adriatic sea and related dose-rate assessment for marine biota", *Radiat. prot. dosim.*, vol. 154, no. 3, str. 320-330, 2013.
12. Petra Planinšek, Ljudmila Benedik, Borut Smodiš, "Comparison of various dissolution techniques for determination of Po-210 in biological samples", In: Proceedings of the 6th International Conference on Radionuclide Metrology - Low Level Radioactivity Measurement Techniques, 17-21 September 2013, Jeju Island, Korea, *Appl. Radiat. Isot.*, vol. 81, pp. 53-56, 2013.
13. JET EFDA Contributors, C. Silva *et al.*, "Observation of geodesic acoustic modes in the JET edge plasma", *Plasma phys. control. fusion*, iss. 2, vol. 55, pp. 025001-1-025001-6, 2013.
14. Borut Smodiš, Marko Štrok, "Partitioning of natural radionuclides in sediments around a former uranium mine and mill", In: Conference proceedings, 10th International Conference on Nuclear Analytical Methods in the Life Sciences (NAMLS-10), January 15-29, 2012, Bangkok, *J. Radioanal. Nucl. Chem.*, vol. 297, iss. 2, pp. 201-207, 2013.
15. Borut Smodiš, Marko Štrok, Marko Černe, Petra Planinšek, Ljudmila Benedik, "Radioanalytical techniques for the determination of ²³⁸U, ²²⁶Ra and ²¹⁰Pb in the environment", In: Proceedings of the 8th International Conference on Nuclear and Radiochemistry, 16-21 September 2012, Como, Italy, *Radiochim. Acta*, vol. 101, no. 8, pp. 519-524, 2013.
16. JET EFDA Contributors, Luka Snoj *et al.*, "Calculations to support JET neutron yield calibration: Modelling of the JET remote handling system", *Nucl. Eng. Des.*, vol. 261, pp. 244-250, 2013.
17. Marko Štrok, Borut Smodiš, "Soil-to-plant transfer factors for natural radionuclides in grass in the vicinity of a former uranium mine", *Nucl. Eng. Des.*, vol. 261, pp. 279-284, 2013.
18. Marko Štrok, Borut Smodiš, Branko Petrinc, Zdenko Franić, "Correcting for potential ²²²Rn loss in ²¹⁰Pb dating of sediments from the South Adriatic Pit", *Quaternary geochronology*, vol. 18, pp. 93-98, 2013.

PUBLISHED CONFERENCE CONTRIBUTION

1. Anže Jazbec, Luka Snoj, Borut Smodiš, Andrej Lešnjak, "Periodic safety review of JSI TRIGA Mark II and inspection of the reactor", In: *Proceedings*, Joint IGORR 2013 & IAEA technical meeting, October 13-18, 2013, Daejeon, Daejeon, 2013, 6 pp.
2. D.B. Syme, Sergei Popovichev, S. Conroy, Igor Lengar, Luka Snoj, Benjamin Choyce Sowden, L. Giacomelli, G. Hermon, D. Plummer, J. Stephens, P. Batistoni, R. Prokopowicz, S. Jednorog, R. Abhangi, R. Makwana, "JET neutron calibration 2013", In: *Proceedings*, 8th Workshop on Fusion Data Processing, Validation and Analysis November 4-6, 2013, Ghent, Ghent, Universiteit Gent, 2013.
3. Andrej Trkov, Luka Snoj, Gašper Žerovnik, "Feasibility study and installation of thermal neutron driven 14 MeV neutron converter into the TRIGA research reactor", In: *Application of research reactors towards research on materials for nuclear fusion technology*, (IAEA TECDOC, 1724), Vienna, IAEA, 2013, pp. 109-114.

NETWORKING INFRASTRUCTURE CENTRE

NIC

The Networking Infrastructure Centre (NIC) is responsible for the administration, development, management and expansion of the core network and ICT services and infrastructure for the Jožef Stefan Institute. It also provides the development of computing, communication, data and security infrastructure for the research departments, centres and services of the Institute.

The NIC's main mission is to provide a high level of connectivity and integration to the local and international communication networks and infrastructures for research departments, programmes, groups and projects and to provide ICT support for the research activities at the Jožef Stefan Institute, including the development, management and administration of the ICT and computing infrastructure, technology, facilities and services at the institute. We work in four main domains: networking infrastructure, network security, network services and distributed network computing.

Networking infrastructure. The Networking Infrastructure Centre provides development, management, administration and support to the physical networking infrastructure for the institute and support to local networks so as to enable internal and internet connectivity to the users and services at the Institute. The institute network includes its wireless networks and a number of dedicated networks for specific services, projects and activities (i.e., dedicated links to other institutions, secure links to the Reactor Infrastructure Centre Podgorica etc.).

Physical network: Due to the increased requirements of several research groups and organizational units, our physical network has been extended and optimized in the past year. A number of core backbone routing and switching upgrades enabled us to provide higher throughput and lower latency as well as expanding the network and its support for IPv6.

In the course of the ongoing upgrading of the physical network infrastructure at the Reactor Infrastructure Centre Podgorica, the physical link to the RIC site has been upgraded with a 10 Gbit/s capacity, which makes it possible to implement multiple dedicated managed VLAN connections and fully integrate the RIC network with the core network at the Institute's main campus. A number of local active switching equipment units have been upgraded to facilitate access to the faster backbone and support newer protocols.

An additional external 10 Gbit/s connection via the ARNES and GÉANT networks has been established with the dedicated LHCONe network (LHC Open Network Environment) to support the high network throughput demands of the ATLAS project inside the WLCG (Worldwide Large Hadron Collider Computing Grid) Nordic computing cloud. The new link replaced the dual 1 Gbit/s links and lessened the load on the Institute's main uplink, the ARNES international links and the Nordic NREN's international links. Internally, we have implemented a redistribution between the relevant OSPF area and the BGP, used on the LHCONe network, enabling us to easily implement additional dedicated international connections (also known as light-paths).

Monitoring: We have implemented a new traffic- and status-monitoring infrastructure based on the free software package Observium, which allows us to respond dynamically to changes in usage and traffic in the context of the Institute's network. We have developed a new system for environmental monitoring, assisting us in the design of higher density racks in the computing centre, while minimising any equipment damage due to overheating. The new system includes our own design of micro-controller-enabled sensors and firmware. The development and deployment was cheaper than purchasing comparable commercial offerings and it replaced our previous solution that used "single wire" sensors with a new one based on the CAN bus, used in industrial and vehicle design, with higher tolerance, longer permissible distances (100 m+ link length) and the possibility to connect more than a hundred sensors to a single bus. The units carry dual temperature sensors to improve the measurement quality and a zero-power-based microcontroller to minimise any measurement drift due



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A network backbone with new routers and an upgraded 10 Gbit/s link to the Reactor Infrastructure Centre Podgorica, an additional external dedicated 10 Gbit/s link, BGP support and increasing Wi-Fi AP numbers are just some markers of the rapid network expansion at the Jožef Stefan Institute.

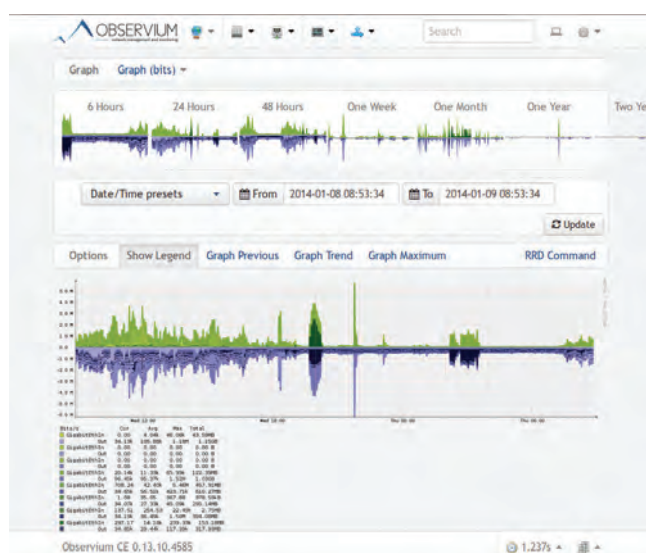


Figure 1: Observium: a view of the daily traffic at a network switch

*Photo by Sašo Radelj

to the sensors' own power use. All the sensors are synchronically calibrated and therefore quite accurate. We use an accuracy of 0.1 °C while the maximum accuracy is stated at 0.02 °C. An in-house firmware and driver solution allows the integration with standard protocols (SNMP) and interoperability with existing monitoring systems, including Observium.

Wireless network: Due to a rapid increase in the number of wireless clients (more users with more devices), we have continued with the deployment of new wireless access points in order to improve on the useful signal density and coverage of the institute's wireless network. We have also completed the testing of wireless network control modules to improve security and introduce wireless network segmentation.

IPv6 support: Due to upgrades and improvements in the core network router protocol support, the active equipment now offers better SNMP protocol support over the IPv6 protocol stack, allowing us to implement network monitoring and administration without the use of the IPv4 stack, thus alleviating the load on the already mostly spent IPv4 address pool. We have been testing a new firmware revision for wireless access points that provides an implementation of the RADIUS authentication over the IPv6 stack, which is already supported in the open source FreeRADIUS package in version 3. The IPv6 protocol family, already fully supported in our public services and user-accessible service, is now also fully usable for internal services and tasks.

Network Security. The NIC is responsible for implementing security measures and policies in three domains: external network connectivity security, security of the network itself and security of the services and software deployments.

External network security is provided with the dynamic management and configuration of deep packet inspection firewall systems and routing configuration, with the exception of dedicated links where passive measures (configuration, filtering and supervision) are used. Security policy and the implementation of the institute network

The internal development of e-mail security and filtering, active network firewalling, introduction of cryptography and certification and close collaboration in national and international security response centres and networks are the basis of an open academic network in the age of the hostile Internet.

is very complex due to the requirements of an open academic network that collide with current security considerations due to the increased detection of threats from the outside network. Therefore, ensuring the secure and open environment requires disproportionate increases in equipment capabilities and efforts in the dynamic security policy configuration.

Since the NIC is responsible for the security of the ICT infrastructure of the Institute, we are active members of relevant institutions and groups, notably the national security response centre SICERT, FIRST (Forum of Incident Response and Security Teams), EGI CSIRT (European Grid Initiative

distributed computing security incident response team), we are part of the response team of the national distributed computing network SLING. The national science certificate agency SiGNET CA, managed by the NIC, is a full member of EU Grid PMA (EU Grid Policy Management Authority) and IGTF (Internet Grid Trust Federation). We have participated in the creation of the Slovenian network technology and security forum NOG (Network Operators Group).

E-Mail: In the field of e-mail security and protection against undesired or malignant messages we have continued in-house software development. The existing Bayes classification systems were expanded to use a Redis database instead of the existing RDBMS, which improved the classification performance and scalability considerably. The new approach has been included in the open source SpamAssassin package and will be available in the 3.4.0 release of the package. Based on this experience with Redis, we have modified the Amavis e-mail filtering system to automatically store received-message source IP addresses with assigned measures in a Redis database so that

this data can be later accessed and reused to accelerate the filtering process when the same source address is encountered in a future message, which accelerates the procedure and makes the system more responsive. We have also used Redis in the "penpal" mechanism, which is used to accelerate the recognition of answers to existing previous messages in an on-going exchange and facilitates the delivery of such messages. The third innovation in this domain is the introduction of an additional black-list system with a new distribution model: the bgp-spam is distributed over the BGP protocol (designed for internet routing). Its dataset originates from the University of Alberta, while the system itself has been developed by the OpenBSD developers. A description of this improvement has been also published.

Cryptography and certification: Currently, DNSSEC signed internet domains are the exception rather than the rule in Slovenia, and the ijs.si domain is not yet signed. However, both DNS servers at the institute have been performing the cryptographic verification procedure since the beginning of 2013. The signing of our domains has been postponed intentionally

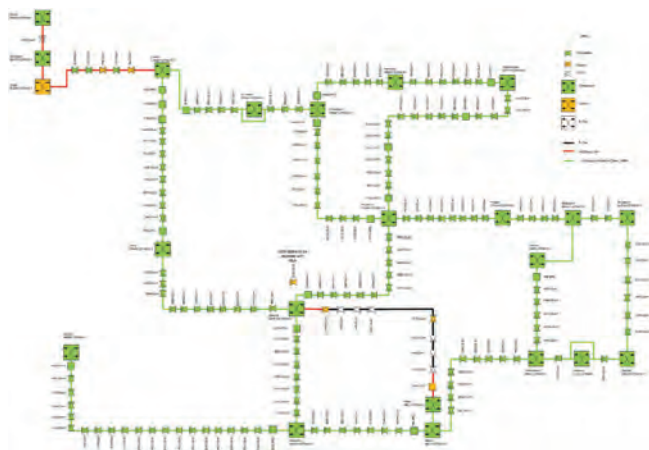


Figure 2: GEANT Infinera network provides higher capacities and dedicated links (Ljubljana bottom right)

since the technology incurs a built-in danger of major denial of service in the case of an error or technical mistake. In order to ensure correctness, a gradual approach to implementation has been adopted. In the first stage, we introduced two different automated mechanisms for the verification of signatures and procedures that have been tested extensively. Based on this security layer, we plan to officially start signing our domain with DNSSEC in 2014. Later, we will introduce the DANE system (integration of TLS certificates with the DNS system) in e-mail transfers and publishing SSHFP records via DNS servers. In addition, we have improved our existing certification support based on the SiGNET CA scientific certificate PKI system by introducing free COMODO server certificates, courtesy of Arnes support, since COMODO certificates are recognised by all the major operating systems and browsers.

We have encouraged the wider adoption of our existing VPN infrastructure, intended to enable our users in remote locations to connect to the institute network securely. The use has risen considerably among the travelling users and conference visitors who often have to deal with networks that block certain types of connections. The VPN is quite resilient and capable of transferring data over a virtual https connection, circumventing such measures.

Network services. The NIC provisions, develops and maintains a number of core and additional ICT services. The most important among these are e-mail (e-mail routing and delivery, in-box management, directory management, web mail services etc.) and world wide web support (central web server, web hosting for users, departments and projects, web directory). Secondary services are provided in support of certain core or specific activities at the Institute, such as web presentations, a conference system, supervision and monitoring, etc. In some of these services the NIC is directly invested in the software or infrastructure development, such as the network time services and e-mail filtering and security, while others are simply administered and maintained.

The third NIC service category is comprised of services supporting our users (calendar, event management, directories) and software/system developers (code repositories, integration and verification, licence management). In addition, we provide physical server hosting and management, aimed primarily at larger projects and systems, the administration of directories for personal computing and user management (such as departmental single sign-on or directory services) and the administration of mission-critical workstations and components.

In 2013 we continued the reorganisation effort started in 2011 with the goal of improving our systems automation and provisioning to manage the increasing load on our personnel due to higher demands and the rise in user numbers, network traffic and supported services. Our efforts stalled in 2013 due to the physical limitations of our computing centre room, its electrical and cooling systems. We have upgraded the electrical installations to partially permit further additions to installed equipment but have not been able to procure an upgrade to the existing cooling system, which has proven inadequate in the last three summers. This has prompted the partial downsizing (discontinuation of non-critical service in hot months) and postponing of a number of larger projects (new archival systems, off-site backup system arrangement with Reactor Infrastructure Centre Podgorica, on-demand physical and virtual servers and data servers for temporary data storage) to 2014.

A number of core services have received hardware and software updates in 2013: in particular the central webmail relay server, web proxy, IMAP service (end user facing server, now with a larger data pool and bigger personal quotas), backup server for managed servers and the authoritative DNS server for our domain. The central web server has been completely replaced and the hosting server (where 45 sites were hosted at the end of the year) has also received a major update. Since the load on our personnel has significantly increased due to the number of users and services, we have begun to implement automation for the maintenance and provisioning of certain core services which we will, physical conditions permitting, extend to on-demand services for users. We have implemented the Poudriere build system for pkg, Jenkins CI system and a testing deployment of the Salt and Puppet configuration/provisioning system.

Due to demands from research departments, we started managing central application development and store management for mobile and desktop software dissemination systems (such as Apple AppStore, Google Play, Blackberry World, Microsoft Store) so that software developers and their departments are free from management

In spite of limitations of space and energy, a number of upgraded and new network services mark increased support for research groups, internal and external collaboration, software development, data protection and the provisioning of infrastructure, services and licences.

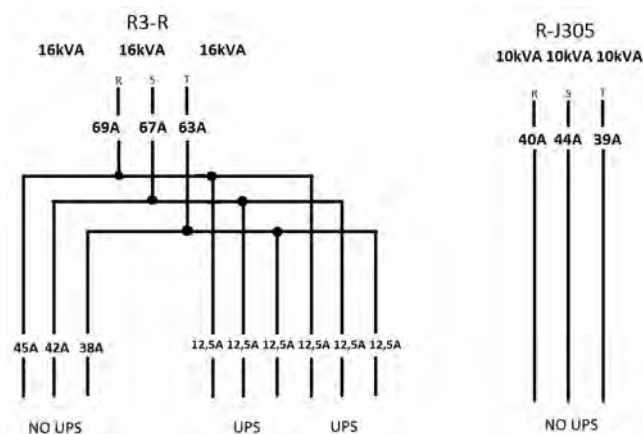


Figure 3: Upgraded electrical installation at the NIC computing centre allowed even denser equipment installation.

burden and membership costs. In addition, we have started a software repository with development and continuous integration support (based on open-source packages Git, GitLabHQ, GitLabCI).

Due to increased interest in a number of services (Eduroam, VPN, web hosting, development tools, etc.) we improved and extended our web-based documentation.

Network computing. In the field of network computing technology and infrastructure, understood as a superset of high throughput computing, high performance computing, grids and clouds (ICT as a service), the NIC is collaborating with individual computing clusters at the institute and is also involved directly in the Slovenian

Our researchers can now use a single authentication mechanism and a single user API to access any of the computing clusters at the Jožef Stefan Institute, Slovenian SLING network computing collaboration or the European EGI infrastructure, putting tens of thousands of computing cores at your fingertips.

National Grid Initiative SLING as a funding member and core partner. The NIC maintains the Slovenian certification agency SLING CA for science, research and grid computing and takes part in the maintenance and support of the core grid network services.

In 2013 we have been successful in continued operations of CiPKeBIP/E8 cluster and the integration of existing JSI clusters in the SLING network running ARC (Nordugrid Advanced Resource Connector) grid middleware. The inclusion of the KRN cluster completed the process of integration. At this point, any institute researcher can use the same interface to access any of the

computing resources in the institute or Slovenian computing network, i.e. Arnes (currently 2300 cores), SiGNET (2194 – F9), Atos (1477 – F1), KRN (1176 – R4/F8) or CiPKeBIP/E8 (984). The same UI and SiGNET CA certificate allows all users in Slovenia to access any other grid-enabled resource in the world.

In the context of SLING, we initiated a cluster administrator working group with regular meetings that facilitates collaboration considerably. But since we were unable to provide acceptable room and infrastructure for our clusters, we were unable to assist with the expansion of the existing resources. Expansion remains of crucial importance, since it is a condition for further collaboration in a number of large international research projects and groups, many of which already count the Jožef Stefan Institute as a member.

In the domain of network computing we have been involved not just in SLING, but also in the European Grid Initiative EGI, NorduGrid ARC collaboration and a number of international projects (ATLAS – dedicated link, Belle2 – computing grid network support planning). SLING has supported a number of research projects and applications in 2013, including high-energy physics, medical sensor and image analysis, theoretical physics, astrophysics, biochemistry, protein folding simulation, knowledge technologies, statistical analysis and fluid dynamics. In a number of cases we have been involved as part of the SLING support group in the parallelization and preparation of computing tasks and administration of required run-time environments.

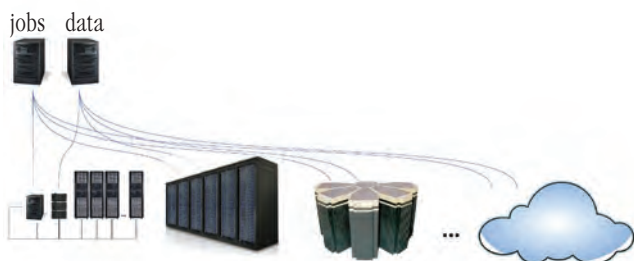


Figure 4: Network computing uses the advances in network development and computing power to present new computing models to the users in Slovenian SLING network and the European Grid Initiative.

R&D GRANTS AND CONTRACTS

1. Slovenian Literature in Unknown Early Modern Manuscripts: Information-Technology Aided Analyses and Scholarly Editions
Jan Jona Javoršek, B. Sc.

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2. **Vladimir Alkalaj, M. Sc., Head**
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8. Matej Wedam

BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Matija Ogrin, Jan Jona Javoršek, Tomaž Erjavec, "A register of early modern Slovenian manuscripts", *Journal of the Text Encoding Initiative*, issue 4, pp. 1-13, March 2013.

SCIENCE INFORMATION CENTRE

SIC

The Jožef Stefan Institute Science Information Centre is the central Slovenian physics library and one of the largest special libraries in Slovenia. Our main tasks are the acquisition, archiving, and loan of books and periodicals, and the input, update and control of bibliographic data of the Institute staff, as requested by the funding ministry.

Our collection covers the fields of physics, chemistry, biochemistry, electronics, information science, artificial intelligence, nuclear technology, energy management and environmental science. We are a full member of the Slovenian library cooperative, COBISS, and use their services to catalogue and loan our materials. You can check what is new in the library, browse our online catalogue, or send inter-library loan requests using our WWW site.

We supplement our comprehensive print collection of core journals with the electronic editions, offered through our WWW site. We subscribe to the electronic collections offered by ScienceDirect, Springer Link, IEEEExplore, Stanford HighWire Press, ACS online editions, AIP electronic editions, IoP online journals, Wiley Interscience. We provide access to the SCOPUS, INSPEC, Crossfire Beilstein, and Web of Science databases, and the Dialog on-line database services.

We manage a bibliographic database of the Institute's production. The database contains about 80,000 records, going back to the Institute's inception in 1949. The records of last year's work are included as part of this report.



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6. Alenka Ana Stante, B. Sc.

7. Jože Škulj

8. Branka Štrancar

9. Nada Tratnik

10. Saša Žnidar

ENERGY EFFICIENCY CENTRE

EEC

The basic activities of the Energy Efficiency Centre are in the efficient use of energy, long-term planning in energy and the reduction of greenhouse-gases emissions. The centre is a focal point for the collection and transfer of energy-efficiency technologies to energy users, the state, energy service and equipment providers, and other interested agencies. At the same time it covers the environmental effects of energy use and conversion. The most significant part of the EEC's activities is thus cooperation with state institutions in the preparation of strategic documents and legislation in the field of efficient energy use, energy planning, distributed electricity production, emissions trading; nevertheless it still remains strongly connected, by its consulting and training role in energy, with industrial companies and other institutions as well as being more and more involved in European research projects.



Head:
Stane Merše, M. Sc.

Energy and the environment

In 2013 the Energy Efficiency Centre with its professional work ensured high-quality support to ministries in the preparation of development strategic documents and the transfer of EU legislation in the field of energy planning, energy efficiency, use of renewables and greenhouse-gases emissions and the reduction of other pollutants.

The accepted EU climate-energy package set new and ambitious goals for Slovenia regarding the increase of energy efficiency, the exploitation of renewables and the reduction of greenhouse-gases emissions. Efficient energy use is a priority field for achieving these goals, in accordance with the requirements of the European Commission and a new directive on energy efficiency (2012/27/EU). Strategic studies for setting national energy goals till 2030 and updated energy balances of the RS until 2030 were elaborated for the Ministry of Transport and Infrastructure. The EEC carried out an evaluation of the operation of the support scheme for the production of electricity from renewable energy sources and cogeneration, together with proposals for upgrading and support tools for planning scheme operation.

The center cooperates with the Statistical Office of the Republic of Slovenia, where it prepares a model calculation of fuels and energy use in households for the national energy statistics. In 2013 the center continued with activities of the state referential centre for energy by the preparation of a set of indicators for energy and environment, as well cooperating in the carrying out of the research of energy efficiency REUS in households and services.

In the field of the reduction of greenhouse-gases emissions, the center elaborated for the Ministry of Agriculture and Environment strategic studies for the preparation of the Operational programme of GHG emissions reduction in the period 2013–2020 with an analysis of the potentials for emissions reduction until 2030 and offered professional support when discussing pollutants from the NEC directive.

A target research project Environment print of agriculture and food processing industry, which by carrying out of support tools established a completely new environment for the environment and energy evaluation of activities and quality support for contractors in the transition to sustainable production, was concluded very successfully and resoundingly.

Promotion of efficient energy use and energy consulting

In 2013 the Energy Efficiency Centre continued with its training activities where the sixth cycle of energy managers' training was successfully concluded within the European programme EUREM. In the autumn already the seventh cycle of training started. Due to the very positive reaction of participants and their interest (in Slovenia there is already more than 140 energy managers with the EUREM licence), it is clear that there is a great need for such training. High-quality knowledge in this field is of key importance for the execution of efficient solutions in practice.

The research and development work of the Energy Efficiency Centre is an important contribution to the preparation of key documents in Slovenia in the field of energy development, energy efficiency, renewables exploitation and the transition of Slovenia to a low-carbon society, with training activities and support to industry it significantly contributes to an increase in competitiveness and development restructuring.

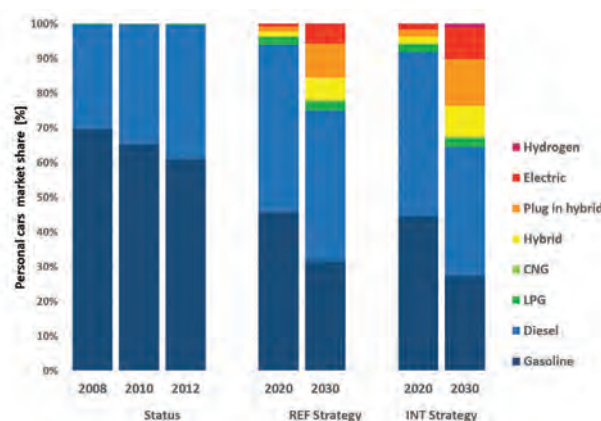


Figure 1: Scenarios for the market development of car technologies. Operative programme of greenhouse-gases emissions' reduction by 2020.



Figure 2: Main award in the category of large enterprises 2013 at the 4th Conference of European energy managers in Nuremberg to Mr. Aljaž Bratina for the project Strategies of energy efficiency of Pošta Slovenije (mentor M.Sc. Boris Sučić, EEC)



Figure 3: Optimization of the operation of ship-to-shore cranes in Luka Koper



Figure 4: Training “Public orders and energy efficiency in buildings” in the framework of the project EFFECT.

In 2013 the Center of Energy Efficiency carried out several consulting tasks in industry and the public sector, where in particular the cooperation with Luka Koper was strengthened. Great economic effects with a reduction of energy-use costs were achieved by the execution of deepened energy audits of individual terminals and by an analysis of the possibilities for the introduction of advanced technologies for transloading. The professional cooperation with Salonit Anhovo, Termoelektrarna toplarna Ljubljana, BTC, General Hospital Brežice, Klinika Golnik, etc., has been continued.

The center continued its professional cooperation with the company Petrol d.d. in carrying out the largest programme of large consumers for ensuring energy savings of end users and expanded its activities also to the company GEN-i. d.o.o.

The center prepared the programme for the jubilee fifteenth conference “Energy Managers Days”, the annual meeting of energy managers, with more than 200 participants, which confirms the quality and public profile of the EEC professional work.

International cooperation

The center cooperated in the preparation of the project and investment documentation for the integrated energy renovation of buildings at the Reactor Centre JSI in Podgorica, where the JSI acquired, from a tender of the Ministry for Education, Science, Culture and Sport, €1,6m of grants for carrying out renovation, which should start in 2014.

In 2013 the EEC carried out as many as 15 international projects, financed from the European Union resources in the framework of the 7th Framework Programme and European Commission programme “Intelligent Energy for Europe” as well as MEDITERAN and South East Europe.

Projects cover activities in the fields of:

- development of innovative systems of energy use monitoring and management in industry (Life Saver, 7th FP),
- increase of energy efficiency of existing non-residential buildings with the introduction of the cost-effective optimization of energy systems Re-Commissioning (Re-Co),
- analysis of the impacts of the introduction of smart energy measurements on the use and costs of energy in low-income housing (Elih-MED),
- inclusion of criteria of energy efficiency in the public tenders (EFFECT),
- increase of transparency of markets with energy services (Transparence),
- compiling and elaboration of current data on renewable energy sources use (EurObserv`ER Barometer),
- monitoring and promotion of cogeneration development (CODE2),
- carrying out the EU directive on energy efficiency (CA – EED),
- carrying out the EU directive on renewable energy sources (CA – RES),
- monitoring of indicators for energy use and energy efficiency in the EU (ODYSSEE MURE EU-27),
- development and carrying out of integrated energy concepts in technological centres (Go ECO),
- central environment energy management as a tool for survival (CEEM),
- advanced financial platform for the promotion of green growth and eco-innovations (Ecofunding),
- strengthening of policies of urban sustainability (UrbanEmpathy).

The projects include cooperation with research and development organisations from Europe with a strong emphasis on concrete applications and the promotion of energy efficiency. In the framework of each project EEC staff took part in numerous foreign professional meetings and visits.

Some outstanding achievements in the past year

1. Preparation of several key support documents for the government of the Republic of Slovenia in the field of energy policy (Green paper and strategic studies for the National Energy Programme), energy efficiency (First and Second National Action Plan for Energy Efficiency), renewable energy sources (Action Plan for Renewable energy sources for the period 2010–2020) and climate policy (Operative programme of GHG emissions reduction up to 2020).
2. Establishment of energy managers training in the framework of the European project EUREM and professional support to industry and other institutions by carrying out energy audits, feasibility studies and other consulting (Goodyear, TE-TOL, Luka Koper, Salonit Anhovo, Telekom Slovenije, BTC, ELENA – Ljubljana, etc.).
3. Cooperation in different international projects in the framework of European Commission programmes in the fields of energy efficiency, energy management, combined production of electricity and heat, promotion of energy-efficient technologies and energy services, exploitation of wood biomass and others.

Organization of conferences, congresses and meetings

1. Energy Managers Days 2013 – 15th Meeting of energy managers of Slovenia, Portorož, Slovenia, 16.–17. 4. 2013
2. With small steps to greater comfort and energy savings, Brežice, Slovenia, 23. 5. 2013
3. Energy efficient public procurement – lighting, household appliances, computer equipment, Ljubljana, Slovenia, 6. 6. 2013
4. Training European energy manager, Ljubljana, Slovenia, 15.–18. 1., 20.–22. 3., 31. 5., 13.–14. 6. 2013
5. Public procurement and energy efficiency of buildings, Ljubljana, Slovenia, 27. 11. 2013
6. Roadmapping of cogeneration in Slovenia, Ljubljana, Slovenia, 26. 11. 2013
7. Roadmapping of cogeneration in Poland, Warsaw, Poland, 4. 12. 2013

INTERNATIONAL PROJECTS

1. 7FP - LifeSaver; Context Sensitive Monitoring of Energy Consumption to Support Energy Savings and Emission Trading in Industry
European Commission
Boris Sučić, M. Sc.
2. IEE - EurObserver2020; The EurObserver Barometer Backs the New RES Directive
European Commission
Dr. Fouad Al-Mansour
3. ELIH-Med - Energy Efficiency in Low-Income Housing in the Mediterranean
Joint Technical Secretariat Med Programme
Aleš Podgornik, M. Sc.
4. EFFECT - Upgrading of Energy Efficient Public Procurement for a Balanced Economic growth of SEE Area
Agenzia Regionale Per L'Energia
Polona Lah, B. Sc.
5. Re-Co; Re-Commissioning-Raising Energy Performance in Existing Non-Residential Buildings
European Commission
Barbara Petelin Visočnik, M. Sc.
6. EIE - C.O.D.E. 2; Cogeneration Observatory and Dissemination Europe 2; IEE/11/910/SI2.615940
European Commission
Stane Merše, M. Sc.
7. CEEM - Central Environmental and Energy Management as a Kit for Survival
City Of Vienna, Department For EU-strategy
Matevž Pušnik, M. Sc.
8. Go ECO; Development and Implementation of Integrated Energy Concepts in Business Parks
European Commission
Peter Bevk, B. Sc.
9. EIE pr. - TRANSPARENSE; Increasing Transparency of Energy Services Markets
European Commission
Damir Staničić, M. Sc.
10. EIE - ODYSSEE MURE 2012; Monitoring of Energy Efficiency in the EU
European Commission
Dr. Fouad Al-Mansour
11. IEE; EurObserver, The EurObserver Barometer (2013-2016)
European Commission

- Matjaž Česen, B. Sc.
12. MED - EMILIE; Enhancing Mediterranean Initiatives Leading SMEs to Innovation in Building Energy Efficiency Technologies
Joint Technical Secretariat Med Programme
Stane Merše, M. Sc.
 13. MED pr.; ECOFUNDING; Innovative Funding Scheme for Energy and Eco Innovation Projects
Joint Technical Secretariat Med Programme
Polona Lah, B. Sc.
 14. URBAN EMPATHY - Empowering Policies on Urban Sustainability
Joint Technical Secretariat Med Programme
Aleš Podgornik, M. Sc.
 15. SEE-ERA.NET PLUS - ISEMIC - Intelligent Information System for Monitoring and Verification of Energy Management in Cities
University Of Zagreb
Boris Sučić, M. Sc.

RESEARCH PROGRAM

1. Modelling and Environmental Impact Assessment of Processes and Energy Technologies
Dr. Fouad Al-mansour

R&D GRANTS AND CONTRACTS

1. Environmental Footprint of Agriculture and Food Processing Industry and Technological Measures for its Lowering in the Future
Dr. Fouad Al-mansour
2. EIE- EUREM.NET, Training and Network of European Energy Managers, N 112/06; EUREM I-VII
Boris Sučić, M. Sc.
3. Evaluation of the Flywheel Technology in the Process of Energy Recovery and Storage in a Mobile Gantry Crane - Case Study Port of Koper
Port of Koper
Boris Sučić, M. Sc.

NEW CONTRACTS

1. Strategic study for the Operation programme for greenhouse gases reduction measures for the period 2013-2020 with an analysis of potential reduction by 2030
Ministry of Agriculture and the Environment
Andreja Urbančič, M. Sc.
2. Development Project for Establishing a Platform of Advanced Services for Energy Management of Household Consumers
Solvera Lynx, d. d.
Aleš Podgornik, M. Sc.
3. Elaboration of a Concept and Methodology of the Research of Energy Efficiency of Slovenia for the Public and Services Sector
Informa Echo, d. o. o.
Stane Merše, M. Sc.
4. Updating of energy balances and strategic studies for the determination of national energy goals
Ministry of Infrastructure and Spatial Planning
Andreja Urbančič, M. Sc.
5. Elaboration of a Strategic Study and a Model for the Design of Determination of Technologies Having Priority at Entering into the Support Scheme in Case of Limited Resources
Ministry of Infrastructure and Spatial Planning
Stane Merše, M. Sc.
6. National Reference Centre for Energy and Refreshment of Energy and Environment Indicators 2013/14
Slovenian Environment Agency
Matjaž Česen, B. Sc.
7. Energy Consumption of Slovenian Households Based on Model Calculation for 2012
Statistical Office of the Republic of Slovenia
Matjaž Česen, B. Sc.
8. EU project GreenBerth - Design of the Methodology for the Validation and Transfer of Technologies Relevant for Energy Efficiency Improvements in Ports' Operations
Port of Koper
Boris Sučić, M. Sc.

VISITORS FROM ABROAD

1. Sara van Rompaey, European Commission, Brussels, Belgium, 17.-19. 9. 2013
2. Prof. Eduardo Maldonado, University of Porto, Portugal, 17.-19. 9. 2013
3. Dr. Christos Maxoulis, Scientific and technical chamber, Cyprus, 17.-19. 9. 2013
4. Carles Sala, Generality of Catalonia, Barcelona, Spain, 17.-19. 9. 2013
5. Slobodan Sofeski, Chamber of small enterprises, Skopje, Macedonia, 9. 10. 2013
6. Stojan Dukoski, Company Key to the Hand, Skopje, Macedonia, 9. 10. 2013
7. Nikola Nestoroski, Company Proaqua, Skopje, Macedonia, 9. 10. 2013

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 11. Aleš Podgornik, M. Sc.
 12. Boris Sučić, M. Sc.
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 14. Igor Ribič

BIBLIOGRAPHY

PUBLISHED CONFERENCE CONTRIBUTION

1. Fouad Al-Mansour, "Challenges and prospects of electricity production from renewables", In: *Conference proceedings*, 6th International Conference on Sustainable Energy and environmental protection, SEEP 2013, 20th - 23rd of August 2013, Maribor, Jurij Kroppe, ed., Abdul Ghani Olabi, ed., Darko Goričanec, ed., Maribor, Faculty of Chemistry and Chemical Engineering, 2013, pp. 184-195.
2. Peter Bevk, Boris Sučić, Matevž Pušnik, "Challenges and opportunities of electricity consumption optimisation in Slovenian households", In: *Proceedings*, 4th International Youth Conference on Energy, IYCE'13, 6-8 June, 2013, Siófok, Hungary, Piscataway, IEEE, 2013, 6 pp.
3. Matjaž Česen, Boris Sučić, Matevž Pušnik, "Assessment of energy efficiency trends and consumers behaviour in Slovenian households", In: *Digital proceedings*, (CD Proceedings (Dubrovnik Conference on sustainable development of energy, water and environment systems)), 8th Conference on sustainable development of energy, water and environment systems, September 22-27, 2013, Dubrovnik, Marko Ban, ed., Neven Duić, ed., Zvonimir Guzović, ed., Dubrovnik, 2013, 5 pp.
4. Polona Lah, Andreja Urbančič, Barbara Petelin-Visočnik, Matjaž Česen, "Analiza delovanja podporne sheme in ocena njenega prispevka k doseganju nacionalnih ciljev na področju OVE in SPTE", In: *Enajsta konferenca slovenskih elektroenergetikov, Laško, 27.-29. maj 2013*, [Ljubljana, Slovensko društvo elektroenergetikov CIGRÉ - CIRED], 2013, 9 pp.
5. Boštjan Pavlič, Franka Cepak, Boris Sučić, Marko Pečkaj, Bogomil Kandus, "Greenification of the heating and hot water preparation system in the Port of Koper and overall energy efficiency improvement", In: *Digital proceedings*, (CD Proceedings (Dubrovnik Conference on sustainable development of energy, water and environment systems)), 8th Conference on sustainable development of energy, water and environment systems, September 22-27, 2013, Dubrovnik, Marko Ban, ed., Neven Duić, ed., Zvonimir Guzović, ed., Dubrovnik, 2013, 5 pp.
6. Barbara Petelin-Visočnik, Boris Sučić, Marko Pečkaj, "Pomen optimizacije delovanja energetskega sistema za učinkovitejšo rabo energije v nestanovanjskih stavbah", In: *EnRe: energy & responsibility: zbornik referatov*, 3. mednarodna konferenca Energetika in klimatske spremembe, Velenje, 20.-21. 6. 2013, Damjan Konovšek, ed., Krško, Fakulteta za energetiko = Faculty of Energy Technology, 2013, 9 pp.
7. Barbara Petelin-Visočnik, Andreja Urbančič, Polona Lah, Stane Merše, Matjaž Česen, "Učinki podporne sheme za obnovljive vire energije in sproizvodnjo toplote in električne energije", In: *Mednarodna konferenca daljinske energetike 2013*, [Ljubljana, Energetika.net, 2013], 3 pp.
8. Aleš Podgornik, Boris Sučić, L. Urošević, "Concept of the intelligent energy technology to support sustainable development of energy utilities, energy savings and CO2 reduction in the complex environment", In: *Proceedings*, 5th International Conference on

- Intelligent Decision Technologies (KES-IDT 2013), Sesimbra, 26.-28. June 2013, Sesimbra, IOS Press, 2013, 8 pp.
9. Matevž Pušnik, Boris Sučić, Fouad Al-Mansour, Luigi Crema, Marco Cozzini, Shahriar Mahbub, Christoph Holzner, "Energy and environmental performance assessment of small and medium-sized enterprises", In: *Digital proceedings*, (CD Proceedings (Dubrovnik Conference on sustainable development of energy, water and environment systems)), 8th Conference on sustainable development of energy, water and environment systems, September 22-27, 2013, Dubrovnik, Marko Ban, ed., Neven Duić, ed., Zvonimir Guzović, ed., Dubrovnik, 2013, 6 pp.
 10. Boris Sučić, Matevž Pušnik, Matjaž Česen, Stane Merše, "Utilisation of energy efficiency and renewable energy sources in urban areas - case study City of Ljubljana, trends up to 2050", In: *Proceedings*, 8th International conference on deregulated electricity market issues in south-eastern Europe, DEMSEE 2013, 24-25 September 2013, Cavtat, Cavtat, 2013, 7 pp.
 11. Boris Sučić, Matevž Pušnik, Maria Maraques, Gunnar Grosse Hovest, "Intelligent energy and environmental management system and its integration to support sustainable development of industrial companies", In: *Digital proceedings*, (CD Proceedings (Dubrovnik Conference on sustainable development of energy, water and environment systems)), 8th Conference on sustainable development of energy, water and environment systems, September 22-27, 2013, Dubrovnik, Marko Ban, ed., Neven Duić, ed., Zvonimir Guzović, ed., Dubrovnik, 2013, 7 pp.
 12. Andreja Urbančič, "O javni obravnavi predloga nacionalnega energetskega programa do leta 2030", In: *Enajsta konferenca slovenskih elektroenergetikov, Laško, 27.-29. maj 2013*, [Ljubljana, Slovensko društvo elektroenergetikov CIGRÉ - CIRE], 2013, 8 pp.
 13. Ljubiša Urošević, Boris Sučić, Aleš Podgornik, "Concept of the interactive platform for real time energy consumption analysis in the complex urban environment", In: *Digital proceedings*, (CD Proceedings (Dubrovnik Conference on sustainable development of energy, water and environment systems)), 8th Conference on sustainable development of energy, water and environment systems, September 22-27, 2013, Dubrovnik, Marko Ban, ed., Neven Duić, ed., Zvonimir Guzović, ed., Dubrovnik, 2013, 11 pp.
 14. Tomaž Vuk, Magda Gabrijelčič, Tomaž Fatur, Boris Sučić, "Kompleksno vrednotenje energetske in okoljske vidikov v energetske intenzivni industriji - pristop LifeSaver na primeru podjetja Salonit", In: *15 let na poti energetske odličnosti: zbornik*, Barbara Petelin-Visočnik, ed., Stane Merše, ed., Ljubljana, Časnik Finance, 2013, pp. 137-142.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Polona Lah, "Učinkovita raba energije in zelena javna naročila", In: *URE, energetika in okolje*, (Zbirka Zelena Slovenija), Jože Volfand, ed., Celje, Fit media, 2013, pp. 110-114.
2. Stane Merše, "Energetska učinkovitost za večjo konkurenčnost industrije", In: *URE, energetika in okolje*, (Zbirka Zelena Slovenija), Jože Volfand, ed., Celje, Fit media, 2013, pp. 56-64.
3. Aleš Podgornik, Boris Sučić, Damir Staničič, Peter Bevk, "The impact of smart metering on energy efficiency in low-income housing in Mediterranean", In: *Climate-smart technologies*, Walter Leal Filho, Franziska Mannke, R. Mohee, Berlin, Springer Link, 2013, pp. 597-614.
4. Andreja Urbančič, Damir Staničič, Barbara Petelin-Visočnik, "Akcijski načrt za učinkovito rabo energije za obdobje 2011-2016", In: *URE, energetika in okolje*, (Zbirka Zelena Slovenija), Jože Volfand, ed., Celje, Fit media, 2013, pp. 21-30.

CENTRE FOR ELECTRON MICROSCOPY

CEM

The Centre for Electron Microscopy (CEM) has the function of a supporting infrastructure center at the JSI that comprises the equipment for electron microscopy that is necessary for the research work of the departments K5, K6, K7, K8 and K9. Other JSI departments, research institutes, universities and industry also have access to the equipment. The users of the CEM equipment are researchers in the field of materials science that are involved in the chemical and structural analysis of materials on the micro and atomic scales. The major equipment of the CEM represents two scanning electron microscopes (JSM-840A and JSM-5800) and two transmission electron microscopes (JEM-2000FX and JEM-2010F). The CEM coworkers also manage the transmission electron microscope JEM-2100 that belongs to the Center of Excellence NiN and in 2009 a newly installed field-emission scanning electron microscope JSM-7600F that was a joint purchase by ten JSI departments and also the faculties NTF and FKKT of the University Ljubljana. In 2010 the electron microscopes were upgraded with the following analytical attachments that were purchased by the Centre of Excellence NAMASTE: CCD camera on JEM-2010F, ADF detector on JEM-2010F and EBSD system on JSM-7600F.



Head:
Prof. Miran Čeh

Scanning electron microscopy (SEM) is used for the morphological studies of either fractured or polished surfaces. Since both scanning electron microscopes are equipped with X-ray spectroscopy (EDXS, WDXS), qualitative and quantitative chemical analyses on the microscale is also possible. Since only a few μm^3 of the material is nondestructively analyzed, the term electron-probe microanalysis (EPMA) is used for such analytical work. Apart from EDXS and WDXS, the new FEG-SEM JSM-7600F is also equipped with electron lithography.

When the structural features on the nanoscale are investigated, however, various techniques for transmission electron microscopy (TEM) are used. In particular, the JEM-2010F is a state-of-the-art TEM/STEM microscope with a FEG (field-emission gun) electron source with a point-to-point resolution below 0.19 nm, which is more than sufficient to observe the atomic columns in crystalline materials. JEM-2010F is also equipped with an annular dark-field detector (HAADF-STEM) for so-called Z-contrast imaging, which enables chemical analysis of a single atomic column on the basis of the measured intensities. Both transmission electron microscopes are additionally equipped with analytical systems for chemical analysis (EDS, EELS). The CEM also comprises the equipment for SEM and TEM specimen preparation, which is the first starting step for all electron microscopy observation procedures. Especially important are the high- and low-energy ion-millers, which enable the preparation of thin foils that are transparent to high-energy electrons.

The analytical work that is performed on the CEM equipment varies, concerning both the investigated materials and/or the applied electron microscopy techniques. While scanning electron microscopy is used mainly for microstructural characterization and the chemical analysis of polycrystalline ceramic materials (functional ceramics, engineering ceramics, bio-ceramics, and composites), magnetic materials, glasses, metals, alloys, etc., transmission electron microscopy is used for structural and chemical investigations of grain boundaries, planar faults, dislocations and precipitates within the same materials. The structural and chemical analysis of grain boundaries is especially important since it is known that the final physical properties, to a large extent, depend on the structure and chemistry of grain boundaries.

In order to be able to perform electron microscopy investigations it is imperative that the equipment in the CEM is well maintained. In view of this, one of the main tasks is to achieve the maximum possible operational time of the microscopes. This complex and expensive equipment needs regular daily maintenance, apart from servicing. Other activities of the CEM are the organization of training courses for the operators and the implementation of new analytical methods, which is realized with the help of the CEM co-workers.

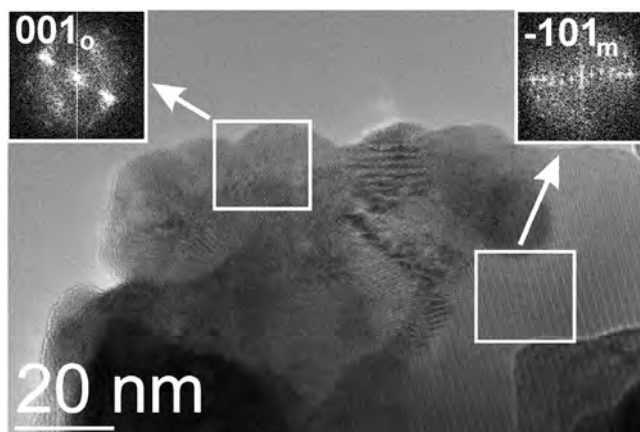


Figure 1: HR-TEM image of milled Nb_2O_5 particles with insets showing FFTs of the selected areas. Nanocrystals of tens of nm are clearly seen on the surface of the larger particle. The diffraction spots of these nanocrystals obtained with a fast Fourier transform (FFT) (inset left) correspond to the orthorhombic (001) plane reflections, while the spots from the larger particle (inset right) correspond to the monoclinic (-101) plane reflections.

Electronic Ceramics: A. Benčan (J. Hreščak, A. Benčan, T. Rojac, B. Malič, J. Eur. Ceram. Soc., 2013, 33 [15-16], 3065-3075)

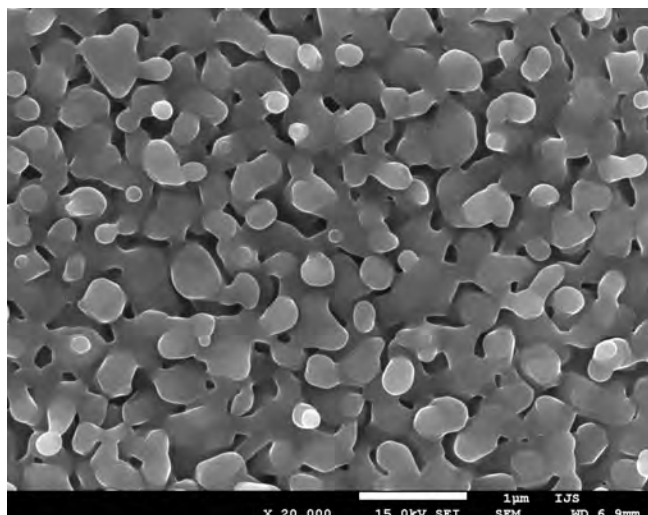


Figure 2: Surface of bioactive calcium phosphate coating.
Engineering Ceramics: M. Štefanič

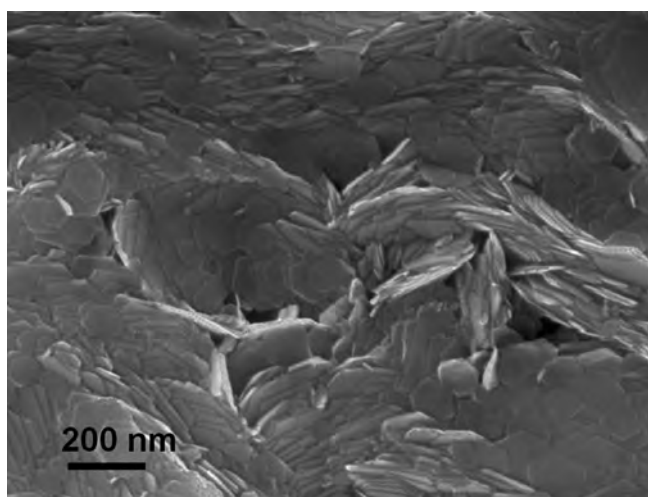


Figure 4: Scanning electron microscopy (SEM) image of $BaFe_{12}O_{19}$ nanoplatelets textured in a magnetic field.
Synthesis of Materials: D. Lisjak

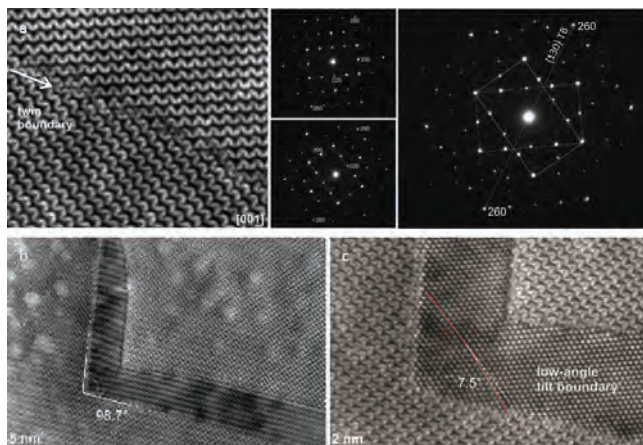


Figure 3a: HRTEM image contact (130) twin boundary in chrysoberyl from the Pratinhas locality in Bahia (Brazil). Transmission electron microscopy (TEM; JEM-2100, Jeol, Japan) using high-resolution TEM and electron-diffraction techniques were used to study the crystallography of the twin boundary. The crystal was oriented along the [001] orientation. The twin boundary is characterized by a straight line. Electron diffraction patterns recorded on both sides of the boundary show that the two crystal domains are related by a 180° rotation around the crystallographic [110]-axis with (130) plane as the twin interface.

Figures 3b,c. HRTEM image of thin TiO_2 precipitates in chrysoberyl crystal. Precipitates lie parallel to the two equivalent {120} planes of chrysoberyl, which intersect at an angle of 98.7° . Some precipitates are composed of only simple slabs of rutile, but quite often L-shaped rutile precipitates are observed. They are composed of two rutile crystals coinciding at the L-junction with their c-axes enclosing an angle of 7.5° .

Nanostructured Materials: S. Drev

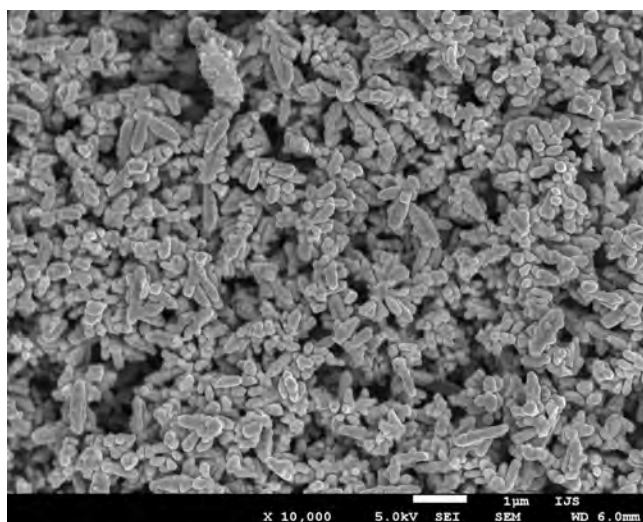


Figure 5: Hydrothermally synthesized $BaTiO_3$.
Advanced Materials: M. Maček

STAFF

Researchers

1. Prof. Miran Čeh, Head

Technical and administrative staff

2. Hamdija Hodžić, B. Sc.

CENTRE FOR KNOWLEDGE TRANSFER IN INFORMATION TECHNOLOGIES CT-3

The Centre for Knowledge Transfer in Information Technologies performs educational, promotional and infrastructural activities and provides for the direct exchange of information and experience between researchers and the users of their research results.

By partnering and actively engaging in different European research projects the centre successfully extends its activities to research and development. Most of the research is performed in the area of knowledge management for traditional and emerging forms of organizations, like networked and virtual organizations. In 2013 the centre was active in several European projects from FP7: PASCAL2 (*Pattern Analysis, Statistical Modelling and Computational Learning 2*), METANET (*Multilingual Europe: a Technology Alliance*), RENDER (Reflecting Knowledge Diversity), ALERT (Active support and Real-time Coordination based on Event Processing in Open Source Software Development), PLANETDATA (A European Network of Excellence on Large-Scale Data Management), e-LICO (An e-Laboratory for Interdisciplinary Collaborative Research in Data Mining and Data-Intensive Science), TRANSECTURES (Transcription and Translation of Video Lectures), X-LIKE (Crosslingual Knowledge Extraction), MOBIS (Personalized Mobility Service for energy Efficiency and Security through Advanced), MEDIAMIXER (Community Set-up and Networking for the Remixing of Online Media Fragments), NRG4CAST (Energy Forecasting), SOPHOCLES (Self-Organised information Processing, Criticality and Emergence in multile), CENTRAL COMMUNITY (Emerging communities for collective innovation in Central Europe), SYMPHONY (Orchestrating Information Technologies and Global Systems Science for Policy Design and Regulation of a Resilient and Sustainable Global Economy), X-LIME (crossLingual crossMedia knowledge extraction), PROASENSE (The Proactive Sensing Enterprise).

In 2013 the centre was active in 16 European projects. The centre prepares and organizes carefully designed educational events, such as conferences, seminars, workshops, and summer schools. They are targeted at experts who would like to apply the latest knowledge and achievements from intelligent data analysis, knowledge technologies, data mining, text mining and decision support to the areas of network organizations, business decisions, finance, marketing, automatization and process control. A special consideration is put on the managers and decision makers who are aware of the strengths and benefits to the success of their business.

All educational events are designed to transfer basic, additional and the latest expert knowledge to the companies, research and educational organizations. In order to make the knowledge transfer efficient we are combining traditional and ICT-supported training methods. For this purpose we are operating a number of training web portals. The most popular one is <http://videolectures.net/>. It now offers more than 18,021 recorded tutorials from different scientific events and is visited monthly by an average of 146,000 visitors from around the world. The main purpose of the portal is to provide free and open access to high-quality video lectures presented by distinguished scholars and scientists at the most important and prominent events. In today's world VideoLectures.NET presents a free knowledge hub, a way of opening up education to everyone for everyone as there is a great need to share educational content on all levels in order to benefit society and foster the economy. It also gives a learning opportunity to audiences of all social levels.

We have successfully collaborated within the Videolectures.net portal with some of the top ten American Universities MIT (Massachusetts Institute of Technology), University of California - Berkeley, YALE, John Hopkins University, University of California, Irvine, and Carnegie Ethics Studio, as well as with the European CERN and ETH from Zurich. VideoLectures.Net has strong connections in OpenCast Foundation, OpenCourseWare Consortium and Knowledge 4 All Foundation Ltd.

The centre also operates a web portal <http://www.ist-world.org> that offers services for automatic data collection and an analysis of European



Head:
Mitja Jermol, M. Sc.

In 2013 the Centre for Knowledge Transfer in IT was actively involved in 16 European projects.



Figure 1: Award ceremony where the Videolectures.Net portal was selected as the WSIS+10 Global Champion

CT3 is operating the web portal <http://videolectures.net/>, which is now the largest world reference portal presenting high-quality scientific lectures.



Figure 2: The creators and authors of the Videolectures.Net portal

In 2013 the portal won the World Summit Award for the best product in the field of creative and innovative e-content in the past decade, granted by the United Nations and UNESCO.

EU programmes (i.e., Erasmus+ and Horizon 2020) related to all aspects of open education, by allowing the rigorous, transparent, and replicable testing of open learning environments, open education theories, new business models, organisational forms, open education software, as well as new and emerging technologies in the education technology market. This unique experimental platform will be sufficiently large, open and flexible to provide for horizontal and vertical links within the education system involving education, research and business institutions, as well as institutions from the European Union, to stimulate the development of new open education frameworks

by targeting different groups and including experimental advanced research and users' realistic assessment.

In 2013 we began the initiative "OpeningUpSlovenia", which will create an environment in which the Slovenian and international partners will develop and test their solutions for "open education".

Our role in the FP7 integrated projects XLike "Cross-lingual Knowledge Extraction" and RENDER – Reflecting Knowledge Diversity, and in three networks of excellence, PASCAL2, PLANETDATA and META-NET, was the support and coordination of all educational and dissemination activities as well as knowledge transfer.

Awards and appointments

1. United Nations and UNESCO award Videolectures.Net portal for best educational product of the decade. The Videolectures.Net was selected as the winner in the "e- Science & Technology" category.

Organization of conferences, congresses and meetings

1. Regional conference "SEE Regional Open Consultation for foresight in ICT Research, Development and Innovation", Ljubljana, 21. 1. 2013
2. Project meeting of the EU project RENDER, 4.-5. 2. 2013
3. Project meeting of the EU project PLANET DATA, 7.-8. 2. 2013
4. Kick-off meeting of the EU project MEDIAMIXER, 14.-15. 2. 2013
5. 8th Student competition in computer science, Ljubljana, 23. 3. 2013
6. Project meeting of the EU project MOBIS, Ljubljana, 15.-16. 10. 2013
7. Technical workshop "Use of advance information technology: the anti-corruption body's perspective", Ljubljana, 28.-29. 10. 2013
8. Organization of the international conference "Internet of education" Ljubljana, 11.-12. 11. 2013

research. The user can perform several simple and complex analyses, predictions and detect trends in research. The database currently contains about 100,000 research organizations, 42,500 research projects and around 2 million experts from Europe. This is an exceptional web service that is being visited daily by an average of 6,000 unique visitors.

We organized the 8th Student Competition in Computer Science, attended by 133 students from Slovenian secondary schools. We have also organized project meetings for different EU projects (RENDER, PLANET DATA, MOBIS and X-LIKE) and an international workshop for the EU project TRANSLECTURES, MediaMixer and X-like "Internet of Education", which was attended by 99 experts. In collaboration with the Slovenian Chamber of Commerce we organized a "Regional ICT RTD Foresight Open Consultation". There were 67 experts from Slovenia and abroad from the e-Health, e-Government and e-Content area.

With our strategic partners we organized the "First Center for Knowledge transfer workshop" with the aim of establishing a new business vision and strategy for the Videolectures.Net portal. In collaboration with the Commission for the Prevention of Corruption we organized a technical workshop "Use of advance information technology", attended by 60 experts.

In 2013 we started negotiations about new initiative "Opening Up Slovenia". The OpeningUpSlovenia case study framework will foster research, development, education and other relevant activities through national and

INTERNATIONAL PROJECTS

1. Video recording and post production of the lectures
Foreign Buyers
Mitja Jermol, M. Sc.
2. 7FP - PASCAL2; Pattern Analysis, Statistical Modelling and Computational Learning 2
European Commission
Mitja Jermol, M. Sc.
3. 7FP - MetaNET; Technologies for the Multilingual European Information Society
European Commission
Mitja Jermol, M. Sc.
4. 7FP - RENDER; Reflecting Knowledge Diversity
European Commission
Mitja Jermol, M. Sc.
5. 7FP - PlanetData
European Commission
Mitja Jermol, M. Sc.
6. 7FP - ALERT; Active Support and Real-time Coordination based on Event Processing in
Open Source Software Development
European Commission
Mitja Jermol, M. Sc.
7. 7FP - transLectures; Transcription and Translation of Video Lectures
European Commission
Mitja Jermol, M. Sc.
8. 7FP - Sophocles; Self-Organised information Processing, Criticality and Emergence in
multilevel Systems
European Commission
Marjana Plukavec, B. Sc.
9. 7FP - MEDIAMIXER; Community Set-up and Networking for the Remixing of Online
Media Fragments
European Commission
Mitja Jermol, M. Sc.
10. 7FP - MobiS; Personalized Mobility Services for Energy Efficiency and Security through
Advanced Artificial Intelligence Techniques
European Commission
Mitja Jermol, M. Sc.
11. 7FP - ProaSense; The Proactive Sensing Enterprise
European Commission
Mitja Jermol, M. Sc.
12. 7FP - SYMPHONY; Orchestrating Information Technologies and Global Systems Science
for Policy Design and Regulation of a Resilient and Sustainable Global Economy
European Commission
Mitja Jermol, M. Sc.
13. 7FP - xLiMe; CrossLingual CrossMedia Knowledge Extraction
European Commission
Mitja Jermol, M. Sc.
14. 7FP - X-Like; Cross-lingual Knowledge Extraction
European Commission
Mitja Jermol, M. Sc.
15. 7FP - NRG4CAST; Energy Forecasting
European Commission
Mitja Jermol, M. Sc.
16. CE - Central Community-Emerging Communities for Collective Innovation in Central
Europe
City of Vienna, Department for EU-strategy
Mitja Jermol, M. Sc.

R&D GRANTS AND CONTRACTS

1. Cloud Assisted Services: CC CLASS
Mitja Jermol, M. Sc.

VISITORS FROM ABROAD

1. Yannis Toliass, Innovatia Systems, Greece, 22. 1. 2013
2. Lyndon Nixon, STI International, Austria, 9. 9. 2013
3. Raphael Troncy, Eurecom, France, 2. 10. 2013
4. Vasileios Mezaris, CERTH-Centre for Research & Technology, Greece, 14. 11. 2013

STAFF

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1. **Mitja Jermol, M. Sc., Head**
2. Davor Orlić, B. Sc.
3. Marjana Plukavec*, B. Sc.
4. Špela Sitar, B. Sc.

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5. Gaber Cerle, B. Sc.

6. Mihajela Črnko
7. Ana Fabjan
8. Adis Krečo, B. Sc.
9. Monika Kropelj, B. Sc.
10. Tanja Zdolšek, B. Sc.

Note:

* part-time JSI member

MILAN ČOPIČ NUCLEAR TRAINING CENTRE

ICJT

The mission of our training centre is training in the field of nuclear technologies and radiation protection. In addition, we are actively informing the public about these technologies.

Training in the area of nuclear technologies is our primary mission. The course *Nuclear technology*, which is the initial theoretical training of future control-room operators, ended in the spring of 2013. This was probably the end of 5-year-long intensive training of new staff for NPP Krško, where a change of generations took place. In the future we expect to conduct the Nuclear Technology course every second year. There was also a course *Basics of nuclear technology*, which is intended for the non-control-room personnel of NPP and participants from other organizations.

There were 25 radiological protection training courses for the medical, industrial and research use of radioactive sources. Two courses were intended for the security personnel of Reactor Centre Brinje and for the transport of nuclear materials.

We have conducted two international courses, funded by EU through the ITER consortium. The bulk of lectures were given by experts from the Reactor Engineering Division (R-4) and from the Reactor Physics Division (F-8).

Public information remains a very important part of our activities. Groups of visitors (mainly schoolchildren, students and various societies) were regularly attending the lectures on electricity from nuclear energy, on radioactive waste, and about fusion. They have also visited the permanent exhibition on nuclear energy. Altogether, there were 161 groups or 7063 visitors this year. Since 1993 our information centre was visited by a total of 149,743 pupils, teachers and other visitors. A significant contribution to public information is the enlarged and revised second edition of the Mini Encyclopaedia of Nuclear Energy that we published in July. This bilingual publication is distributed free of charge to our visitors. We have continued monitoring and analysing media reports on nuclear energy. An important part of the information activity is the *Fusion Expo* project, which is funded by the European Fusion Development Agreement. The travelling exhibition on fusion has been set up in London (United Kingdom), Goteborg (Sweden), Tartu (Estonia), Rust (Germany), Prague (Czech Republic) and Antwerp (Belgium).



Head:
Prof. Igor Jenčič

We have prepared a thoroughly revised and expanded second edition of the bilingual publication “Mini Encyclopaedia of Nuclear Energy”.



Figure 1: Conclusion of the Nuclear Power Plant technology course



Figure 2: Exercise of trainees in the control room of the TRIGA research reactor

Table of training activities at Nuclear Training Centre in 2013

Date	Title of the course	Partici- pants	Lecturers	Weeks	Participants × weeks
5. 11. 12-5. 4.	Nuclear technology. Theory	23	19	13	299
28. 1.-4. 2.	Radiation protection for RP department staff - Refresher course	9	4	1.0	9.0
11. 2.	Radiation protection for workers at Ljubljana Airport	7	1	0.2	1.4
18. 2.-22. 2.	Radiation protection RZ2 for NPP subcontractors	22	7	1.0	22.0
25. 2.-27. 2.	Radiation protection for industrial and other practices (unsealed sources)	2	5	0.6	1.2
25. 2.-27. 2.	Radiation protection for industrial and other practices (sealed sources)	8	4	0.6	4.8
5. 3.	Radiation protection for industrial and other practices (unsealed sources) - Refresher course	2	5	0.2	0.4
5. 3.-6. 3.	Radiation protection for industrial and other practices (radiography) - Refresher course	2	4	0.4	0.8
5. 3.	Radiation protection for industrial and other practices (sealed sources) - Refresher course	26	4	0.2	5.2
5. 3.	Radiation protection for industrial and other practices (measurement of roadway density and humidity) - Refresher course	4	4	0.2	0.8
7. 3.	Training extension for RP Officers	8	2	0.2	1.6
6. 5.-4. 6.	Basics of nuclear technology. Theory	11	13	4.4	48.4
14. 5.-15. 5.	Annual refresher course for security officers	13	8	0.4	5.2
20. 5.-24. 5.	Training course on "Requirements and safety evaluation of PSA for NPP"	12	9	1.0	12.0
22.5.-23. 5.	Security officers for transport of nuclear materials - Refresher course	13	7	0.4	5.2
5. 6.-28. 6.	Basics of nuclear technology. Systems	12	11	3.4	40.8
4. 7.	Radiation protection for industrial and other practices (sealed sources) - Refresher course	2	1	0.2	0.4
2. 9.-6. 9.	Training Course on "Safety evaluation of SAR and oversight for Research Reactors"	14	7	1.0	14.0
3. 9.	Radiation protection for industrial and other practices (sealed sources) - Refresher Course	3	1	0.2	0.6
7. 10.-9. 10.	Radiation protection for industrial and other practices (unsealed sources)	2	5	0.6	1.2
7. 10.-16. 10.	Radiation protection for Dental Radiography	2	5	0.4	0.8
7. 10.-18. 10.	Radiation protection for medical and veterinary workers - Nuclear medicine workers	6	10	1.0	6.0
7. 10.-10. 10.	Radiation protection for industrial and other practices (measurement of roadway density and humidity)	1	4	0.8	0.8
7. 10.-9. 10.	Radiation protection for industrial and other practices (sealed sources)	7	4	0.6	4.2
15. 10.-18. 10.	Radiation protection for Nuclear Medicine Dpt. - Refresher course	2	7	0.4	0.8
15. 10.-17. 10.	Radiation protection for industrial and other practices (radiography) - Refresher course	2	4	0.4	0.8
15. 10.	Radiation protection for industrial and other practices (measurement of roadway density and humidity) - Refresher course	2	4	0.2	0.4
15. 10.	Radiation protection for industrial and other practices (unsealed sources) - Refresher course	9	5	0.2	1.8
15. 10.	Radiation protection for industrial and other practices (sealed sources) - Refresher course	14	4	0.2	2.8
16. 10.	Radiation protection for dental radiography - Refresher course	0	1	0.2	0.0
17. 10.	Training extension for RP officers	7	2	0.2	1.4
25. 11.-27. 11.	Radiation protection for workers of Cinkarna Celje Company	4	1	0.4	1.6
TOTAL		251	172	34.2	495.4



Figure 3: Lecture about radioactivity for school children



Figure 4: Lecture about energy for primary school children

INTERNATIONAL PROJECTS

- 7FP - EAGLE; Enhancing Education, Training and Communication Processes for Informed Behaviors and Decision-making related to Ionizing Radiation Risks
European Commission
Rado Istenič, B. Sc.
- 7FP - Fusion Expo; Fusion Expo Support Action under EFDA Work Programme, Task Agreement WP10-PIN-FUSEX
Ministry of Education, Science and Sport
Tomaž Skobe, B. Sc.
- 7FP - EURATOM; Public Information in the Association - 6.1.1.-FU
Ministry of Education, Science and Sport
Prof. Igor Jenčič
- Realization of the International Workshop: "Group Fellowship Training Programme on Research Reactors" (IAEERRI11, IAEERRI11A, IAEERRI12), ICJT, 7.-18.3.2011; 7.-18.11.2011, 1.-12.10.2012
IAEA - International Atomic Energy Agency
Saša Bobič
- Training and Tutoring for Experts of the NRAs and their TSOs for Developing and Strengthening their Regulatory and Technical Capabilities - INSC Project MC.03/10 - LOT 1: Training and Tutoring for Nuclear Regulatory Authorities and their TSO's: ITER-consult Srl
Saša Bobič
- Edition of Slovene-English Publication "Mini Encyclopaedia of Nuclear Energy"
Foreign Clients
Prof. Igor Jenčič
- Design, Development and Delivery of Training Material for the Train-the-Trainer's Package on Nuclear Safety
IAEA - International Atomic Energy Agency
Prof. Igor Jenčič

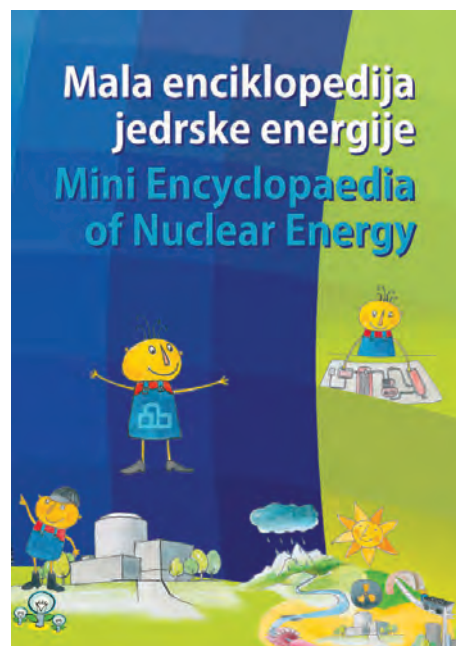


Figure 5: Mini Encyclopaedia of Nuclear Energy

R&D GRANTS AND CONTRACTS

- Trainings of the RZ for Foreign Market
Matejka Južnik, M. Sc.
- Services in the Year 2013
Matejka Južnik, M. Sc.

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- Nataša Medved, B. Sc., left 01.09.13*
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- Vesna Slapar, B. Sc.
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- Nina Udir, B. Sc.

Technical and administrative staff

- Saša Bobič
- Matejka Južnik, M. Sc.
- Borut Mavec, B. Sc.

BIBLIOGRAPHY

PUBLISHED CONFERENCE CONTRIBUTION

1. Radko Istenič, Igor Jenčič, "Public Opinion about Nuclear Energy–Year 2013 Poll", In: *Proceedings*, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, 6 pp.
2. Matjaž Koželj, "Where is the border between professional and radiation protection education and training", In: *ETRAP 2013*, 5th International Conference on Education and Training in Radiological Protection, 12-15 March, Vienna, Austria, Brussels, ENS = European Nuclear Society, 2013, pp. 279-284.
3. Matjaž Koželj, Radko Istenič, "Radioactivity experiments for schools", In: *Proceedings*, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013, pp. 1313.1-1313.9.
4. Tomaž Skobe, "Travelling exhibition Fusion Expo", V: *Proceedings*, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12, Leon Cizelj, ed., Matjaž Leskovar, ed., Mitja Uršič, ed., Ljubljana, Nuclear Society of Slovenia, 2013.

RADIATION PROTECTION UNIT

SVPIIS

The SVPIIS has been involved in ionizing-radiation measurements and radiation protection since the commissioning of the TRIGA MARK II Research reactor in 1966. The responsibility of SVPIIS is the radiation control of all the activities at the Institute dealing with ionizing radiation. Our main task is the supervision of the reactor and the 17 laboratories that use sources of ionising radiation in their research work. More than one hundred different sources are used, such as sealed sources, open sources, X-ray units and the accelerator TANDETRON, all of which need regulatory control.

SVPIIS is authorized by the Slovenian radiation protection administration to perform control in industrial and research institutions dealing with open or sealed radioactive sources and X-ray units. Furthermore, we are involved in radioactive waste management.

The measurements of dose rate, contamination and gamma spectrometry are performed using an accredited method (EN ISO/IEC 17025).

Personal dosimetry

The personal doses of 123 workers that regularly or occasionally deal with ionizing radiation were monitored with Thermo Luminescent Dosimeters. The maximum individual yearly dose was 0.133 mSv. This is only 0.6 % of the regulatory limit for occupational exposure (20 mSv per year) and 13 % of the limit for the general public (1 mSv per year). Collective dose at JSI in the year 2013 was 1.03 man mSv.

Supervision of research reactor and laboratories

The controlled area of the Research reactor, the Hot Cell Facility and the Department of Environmental Sciences was monitored on a weekly basis. During some activities the constant presence of a radiation-protection worker was needed (i.e., for the opening of activated samples or radioactive-waste management). Measurements of dose rate (Figure 1), surface contamination, contamination of different objects and personal contamination were performed routinely. In most cases, no or very low contamination levels could be measured in the controlled areas.

In 2013 we performed 18 inspections in other JSI laboratories. An independent inspection by an external authorized institution was performed in the SVPIIS laboratory and two additional laboratories at the JSI. There were no deficiencies recognized that could be important for radiation protection.

At present, 107 sources of radiation are used, which require regulatory control. Additionally, 384 low-activity sources are also used in different laboratories.

Environmental measurements

The environmental monitoring of the Reactor Center was performed in accordance with the existing program. The monitoring program consists of effluent measurements and measurements of samples in the environment. The activity concentrations of the gamma emitters in water samples, filters, noble gases, soil samples and sediment samples were measured periodically. About 350 different samples were measured with gamma spectrometry. Environmental passive dosimeters were used to monitor radiation levels in the surroundings of the reactor. Based on the effluent measurements and a conservative, environmental transfer model the effective dose to the reference group of the public was estimated to be less than 1 μ Sv/year. The public exposure in 2013 due to activities at the Reactor Center was insignificant.



Head:
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Figure 1: Dose-rate measurements near the experimental channels in the hall of the TRIGA MARK II reactor



Figure 2: In-situ gamma spectrometry measurements in the evacuated zone, 8 km from the Fukushima Daiichi Nuclear Power Station

Expert assessments and measurements for outside customers

The Radiation Protection Unit is authorized for supervision measurements and expert assessments in the field of radiation protection. In the past year several radiological control investigations were carried out in industrial and research institutions. Our group has participated in the evaluation of radiological monitoring at Krško NPP, research reactor TRIGA and storage for low- and intermediate-level waste in Brinje.

In the field of international cooperation our staff has participated together with the Research department for low and medium energy physics (F2) and the Institute for occupational safety in the RANET exercise organised by IAEA in Japan. We performed radiological measurements (Figure 2) in the evacuated zone of the damaged Fukushima Daiichi NPP. The Slovenian team left a good impression on the proficiency level. Experience gained in the field is a good basis for future emergency planning and preparedness.

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BIBLIOGRAPHY

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Matjaž Stepišnik, "Površinske vode", In: *Poročanje in ovrednotenje zračnih in tekočinskih imisij ter meritev zunanjega sevanja v okolici NEK*, Matjaž Korun, et al, 1. izd., Ljubljana, Institut Jožef Stefan, 2013, pp. 5-22.

SCIENTIFIC MONOGRAPH

1. Matjaž Korun, Matjaž Stepišnik, Benjamin Zorko, Jasmina Kožar Logar, Gregor Omahen, Branko Vodenik, Boštjan Črnič, Katarina Vogel-Mikuš, Benjamin Zorko (urednik), Denis Glavič-Cindro (urednik), *Poročanje in ovrednotenje zračnih in tekočinskih imisij ter meritev zunanjega sevanja v okolici NEK*, 1. izd., Ljubljana, Institut Jožef Stefan, 2013.

CENTER FOR TECHNOLOGY TRANSFER AND INNOVATION CTT

In January 2011 the Center for Technology Transfer and Innovation (CTT) was established at the Jozef Stefan Institute. Its principal activities are the transfer of technology and know-how from the JSI to industry as well as education and research work in the field of innovation and innovation management, and the implementation of specific technology projects.

In 2013, the Centre for Technology Transfer and Innovation (CTT) was involved in nine major projects. We have participated in EU projects from different funding-scheme programs. Within the CIP program scheme we were involved in the EEN (Enterprise Europe Network). The project EnvImpact (Increasing the impact of Central-Eastern European environment research results through more Effective dissemination and exploitation) under the 7th PF has been concluded. Under the 7th FP we continued our involvement in the TIPS (Enhancing the capacity of EU Transport Projects to transform research results into innovative products and services). Within the Alpine Space Programme we participated with the Alps4EU (Alpine Space Clusters Initiative for EU) and with the project FIDIAS (Innovative Financial Instruments for Sustainable Development and Alpine Spaces). In the context of South East Europe, we participated with the project EVLIA (Making full value of good ideas by leveraging Intellectual Assets for financing SMEs in SEE), in the framework of the Central Europe, together with the department CT3 we continued our work on the project Central community (Emerging communities for collective innovation and Central Europe). We also work on the project IPforSMEs (The Role of Intellectual Property (IP) and creating regional value through interregional exchange IP) under the Cross-Border Cooperation Slovenia-Italy. We were also involved in national projects: we started our activities on the project KTT (Consortium for technology transfer), ZS (Scientific meetings, ARRS) and concluded our work on the project TP PROINCOR (Technology Park Ljubljana). We also carried out some commercial projects with a small contract value.

Head:
Dr. Špela Stres

Our center carried out the activities within the framework of eight EU projects in different programme schemes, one cross-border project Slovenia-Italy and acquired two new projects.

We maintain an online entry point with a set of JSI competencies to communicate with business partners and the general public at <http://tehnologije.ijs.si>. We were involved in the establishment of two spin-out companies and we were supporting researchers in the preparation of two proposals for spin-out companies. In 2013 we dealt with 10 invention disclosures and with 4 patent applications. In 2013 we conducted over 40 different cases related to the JSI's intellectual property, we established the proper legal basis and contracts in all cases where it was necessary (10 contracts of the new type).

Assistance with intellectual property protection and the licensing/commercialization of technologies is performed, firstly by the assessment of the technology and market potential. Secondly, we review the patent databases and thirdly we help researchers protect intellectual property and help them during the implementation of the invention in the economy. We evaluated 21 technologies according to the state of the art and potential market. We run market analyses and active marketing operations for the 14 best examples of technologies.

In 2013 the activities of the Consortium for Technology Transfer (KTT) began. The consortium consists of representatives of technology transfer offices from the Jozef Stefan Institute (head of KTT), the University of Ljubljana, the National Institute of Chemistry, the University of Maribor, the National Institute of Biology and the University of Primorska. The basic activity of the consortium is to provide assistance in the managing and marketing of intellectual property and assistance in the preparation of non-disclosure agreements of trade secrets, contracts for the acquisition and marketing of technologies. Within the consortium, 45 technologies were considered in 2013, of which 33 technologies were prior to the first patent application (secret know-how). Of the remaining technologies, 9 were registered at the Intellectual Property Office (SIPO), 8 technologies were filed as international patent applications (WIPO, EPO), and 1 technology has been registered at



Figure 1: 6. International Technology Transfer Conference

We organized 35 company visits at the JSI. The researchers from the JSI, together with the industrial partners, identified 49 new development projects.

In September we organized the 6th International Technology Transfer Conference and awarded two prizes for the best innovations with a total value of €2000.



Figure 2: Award ceremony for the innovation with highest commercial potential on 6th International Technology Transfer Conference

During the JSI Week of Open Doors there were more than 1000 visitors to the Institute, with an additional 41 visits being organized throughout the year, bringing more than 1200 visitors to the Institute. In total we had over 2200 visitors.



Figure 3: JSI Open doors 2013 - 23. 3. 2013



Figure 4: JSI Open doors 2013 - 23. 3. 2013

the U.S. Patent and Trademark Office (USPTO). We had 15 cases of activities regarding the establishment of the spin-out companies, and for 8 technologies active marketing operations were carried out.

To researchers we offer the following services: assistance in patenting, licensing, creation of spin-out companies, preparing and submitting patent applications, the implementation of active marketing, and search for business partners, preparation of technology offers and technology demands, preparation of non-disclosure agreements (NDAs) and the preparation of licensing agreements and other documents related to the protection of intellectual property.

To assist in the commercialization of the R&D results, the inventors, researchers and entrepreneurs from Slovenia are turning to us. To increase the active collaboration between researchers and industry we organized visits to/from more than 35 companies and researchers have identified over 49 new development projects. We helped several research departments with the submission of European project proposals.

During the JSI Open Doors event, since 2010 called the Week of Open Doors, the Institute was visited by more than 1000 people and they learned a lot about the Institute, and the structure and activities of individual laboratories. In addition, we recorded 41 other visits (more than 1200 visitors) from kindergartens, primary schools, high schools, institutions, as well as the individuals from all over Slovenia and abroad. In total, in 2013, over 2200 people visited the Institute and learned about the work of the largest research institution in Slovenia.

Colleagues at the CTT participated, as organizers or co-organizers, at six events, as well as attending conferences, training sessions and other meetings. A total of over 30 task forces and other meetings were carried out, with the aim of establishing an integrated support environment.

We would especially like to highlight the organization of the 6th International Technology Transfer Conference, held on 17 September 2013, co-joined with Innovation Day 2013, organized by the Slovenian Chamber of Commerce. The conference awarded a prize for the most innovative project. The International Commission of the representatives of venture capital awarded a prize of €2,000 for innovative ideas coming from the Jožef Stefan Institute. At the conference we also organized meetings for companies and researchers from public research organizations. In all, 22 such meetings took place.

Organization of conferences, congresses and meetings

1. Organization of the week of JSI Open doors, 23. 3. 2014
2. Enterprise Europe Network event - co-organizer: 2nd International B2B Software Days - The Big Data Challenge, Vienna, Austria, 10. 4. 2013
3. Enterprise Europe Network event - co-organizer: VMC Forma Tool Brokerage Event, Brno, Czech Republic, 8.-9. 10. 2013
4. Enterprise Europe Network event - co-organizer: Technology Dating, Videm, Slovenia, 17. 5. 2013
5. Organization of Young researchers 2013: Academic Entrepreneurship for young researchers at JSI, 24. 5. 2013
6. Organization of 6th International Technology Transfer Conference in collaboration with Innovation day 2013 - Chamber of Commerce and Industry of Slovenia, Brdo pri Kranju, Slovenia, 17. 9. 2013
7. Co-organization of TIPS training academy event: intellectual property rights; the market potential for your R&D results; funding and financing facilities to bring your research to the market; support initiatives to find potential partners for further development of your R&D results, Prague, Czech Republic, 25.-28. 11. 2013

INTERNATIONAL PROJECTS

1. Evaluation of Industrial Projects for Italian Partner
Veneto Innovazione Spa
Dr. Špela Stres
2. 7FP - ENVIMPACT; Increasing the Impact of Central-Eastern European Environment Research Results through more Effective Dissemination and Exploitation
European Commission
Marjeta Trobec, B. Sc.
3. 7FP - TIPS; Enhancing the Capacity of EU Transport Projects to transform Research Results into Innovative Products and Services
European Commission
Dr. Špela Stres
4. Alps 4 EU
European Commission
Dr. Špela Stres
5. IPforSMEs - Intellectual Property for Small and Medium Sized Companies
Government Office for Local Self-Government and Regional Policy
Dr. Špela Stres
6. FIDIAS - Innovative Financial Instruments for Sustainable Development in Alpine Space
European Commission
Dr. Špela Stres
7. CE - Central Community-Emerging Communities for Collective Innovation in Central Europe
City of Vienna, Department for EU-strategy
Dr. Špela Stres
8. SEE; EVLIA - Making Full Value of Good Ideas by Leveraging Intellectual Assets for Financing SMEs in SEE
Joint Technical Secretariat See Programme
Dr. Špela Stres
9. MED - FireMed; Innovative Financial Instruments to support Energy Sector SMEs in Med Area
Joint Technical Secretariat Med Programme
Dr. Špela Stres
10. CIP - EACI; EASME - EIC&IRC Slovenia 1, EIC&IRC Services in Support of Business and Innovation
European Commission
Marjeta Trobec, B. Sc.

R&D GRANTS AND CONTRACTS

1. Technology Transfer in Public research institutions
dr. Špela Stres
2. IPforSMEs - Intellectual property for Small and Medium sized Companies
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BIBLIOGRAPHY

ORIGINAL ARTICLE

1. Nataša Lindič, Maruška Budič, Toni Petan, Binyamin A. Knisbacher, Erez Y. Levanon, Nika Lovšin, "Differential inhibition of LINE1 and LINE2 retrotransposition by vertebrate AID/APOBEC proteins", *Retrovirology*, vol. 10, art. no. 156, pp. 1-16, 2013.

INDEPENDENT COMPONENT PART OR A CHAPTER IN A MONOGRAPH

1. Špela Stres, "NPEs vs. a proposed EC IP fund : a comparison of European Commissions's plans on setting up", V: *Master of laws in*

intellectual property collection of research papers 2011, Nair Anand, ur., Claudio Tamburrino, ed., Angelica Tavella, ed., Napoli, Edizioni Scientifiche Italiane, 2013, pp. 475-490.

MENTORING

1. Marjeta Trobec, *The government's impact on networking among Slovenian companies*: master's thesis, Ljubljana, 2013 (mentor Mateja Drnovšek).