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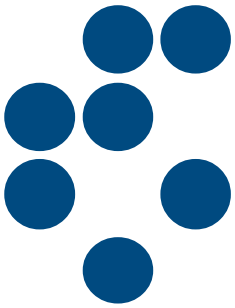
AUGUST 2006



# Jožef Stefan Institute - Annual Report 2005

Jožef Stefan Institute, Ljubljana, Slovenia

Annual report 2005

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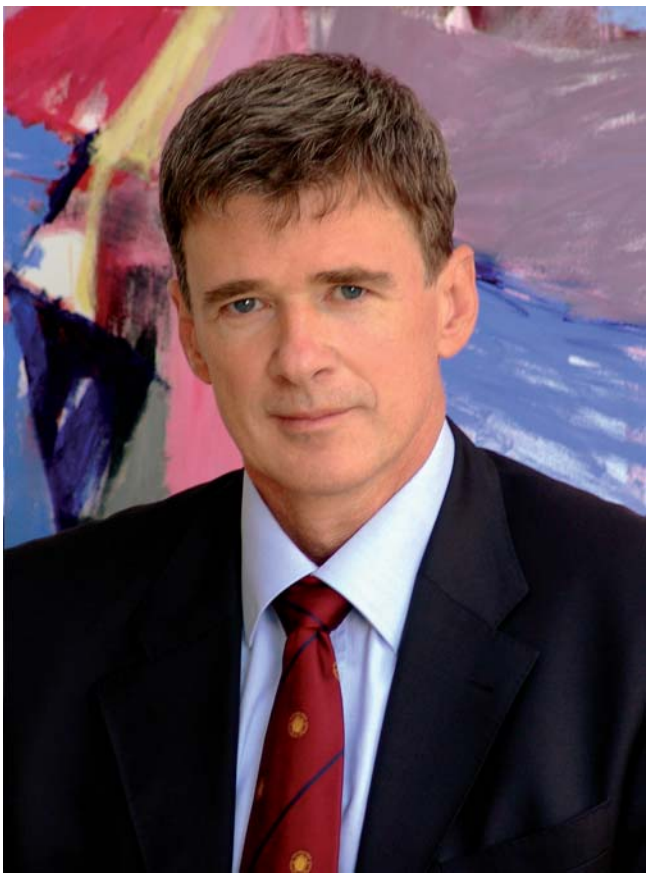
Ljubljana, August 2006

# CONTENTS

# INTRODUCTION

*The Jožef Stefan Institute (JSI) is composed of twenty-four departments, specialising in various areas of physics, including nuclear physics, chemistry, biochemistry and environmental sciences, electronics and information technology. The main subjects concern nanotechnology, new materials, biotechnology, production technology, communication technology and the technology of knowledge, environmental technology, reactor technology, energetics as well as others. The mission of the JSI is to create and transfer knowledge to benefit Slovenian society and mankind in general. The JSI provides the best education based on the research and development of technologies at the highest international level.*

*I trust that a society is worth as much as its attitude towards science and, on the other hand, that science is worth as much as its attitude towards society. Our aim, therefore, is to continuously create a balance between basic science, whose purpose is to make new scientific discoveries, and applied science, whose purpose is to develop new technologies and products, relating to health, the environment, safety, as well as industrial development. The initiatives of the JSI in the past year emphasize its active involvement in European and in particular in Slovenian development strategies.*



*Director of the Jožef Stefan Institute*
*Prof. Jadran Lenarčič*

*Out of the eight Centres of Excellence that were founded in the past year in Slovenia, four are coordinated by the JSI. These centres specialise in nanotechnology, new materials, control technology and environmental technology. Each of them involves more than twenty partners from industry and research. In the next years we plan to build and put into operation a system of new laboratories for the development of advanced technologies and education, integrating these Centres of Excellence in order to combine basic science with technological development and education. Last year we also started to organize a series of meetings with our industrial partners. The first one was entitled "Institute and industry", which was followed by "Institute and opportunities". The attendees were government ministers and the leading managers from over one hundred companies. In order to ensure our connection with industry, we have established the Industrial Council of the Institute, whose members are some of Slovenia's most prominent economists.*

*The JSI is closely integrated with university education in Slovenia. Every year about thirty to forty Ph.D. students finish their theses at the JSI. A recent change in the legislation now allows the JSI to officially participate in education programmes at the university level. The JSI is a co-founder of the University of Nova Gorica (formerly the Nova Gorica Polytechnic) and of the Jožef Stefan International Postgraduate School. To all this we have recently added a new cooperation agreement between the JSI and the University of Ljubljana, and we are in the process of negotiating with the University of Primorska.*

*The JSI collaborates with universities and research institutions around the world. In 2005 we have seen a significant increase in the number of EU research projects in which the JSI is involved. We organize international conferences and take part in many international exchanges. Many of the achievements of our research groups are recognized*

*internationally and our scientists are invited scholars at prominent universities and institutes abroad. In the past year the JSI has signed an agreement with Joanneum Research, in Austria, an important technologically oriented institute. I am expecting a fruitful collaboration, especially in the field of bringing together science and technology. I also see this as a platform for increasing the level of technological exchange between Slovenia and Austria. The first joint research projects are already in preparation.*

*I would also like to take this opportunity to express my gratitude to all the employees of the JSI for their enthusiasm and excellent work during 2005.*

*Prof. Jadran Lenarčič*
*Director of the Jožef Stefan Institute*

*The Jožef Stefan Institute buildings in Ljubljana from the air*

# 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

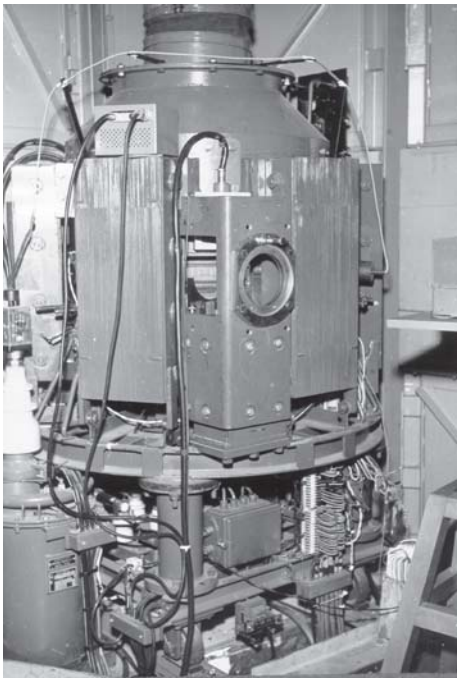
**1958**
- Institute reorganised and new fields of activity defined: nuclear physics, solid-state physics, chemistry, and radiobiology

**1959**
- Institute renamed the Jožef Stefan Nuclear Institute. The major source of income was provided by the Yugoslav Atomic Energy Commission

**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



*Betatron at Jožef Stefan Institute*

*Institute buildings after the opening 1953*

**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

**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

*The Reactor Centre in Podgorica was built in 1966*

**1979**
- Contract defining cooperation between the Jožef Stefan Institute and the Nuclear Power Plant Krško is signed
- First robot in Slovenia 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

**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

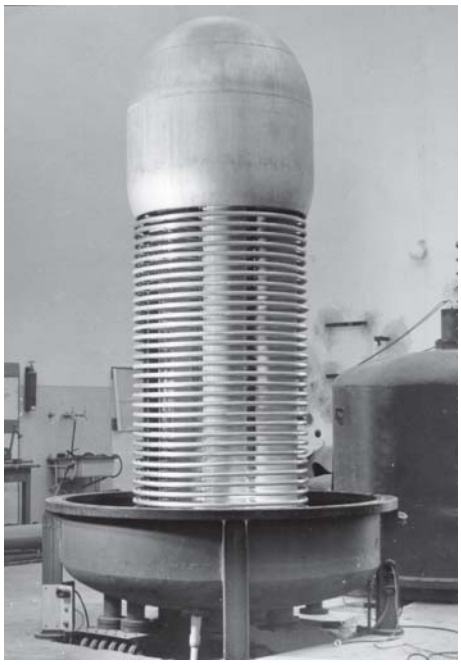
**1988**
- Milan Čopič Nuclear Training Centre established

**1990**
- The first Slovenian supercomputer, CONVEX, installed at the Jožef Stefan Institute
- Construction of new laboratories completed

**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



*Van de Graaff accelerator, 1956*

**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

# 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
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**Lucijan Šinkovec, B. Sc.**, 1959 - 1963
**Prof. Milan Osredkar**, 1963 - 1975
**Prof. Boris Frlec**, 1975 - 1984
**Prof. Tomaž Kalin**, 1984 - 1992
**Prof. Danilo Zavrtanik**, 1992 - 1996
**Prof. Vito Turk**, 1996 - 2005

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*Prof. Spomenka Kobe*
**Advanced Materials (K-9)**
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**Environmental Sciences (O-2)**
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**Intelligent Systems (E-9)**
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**Workshops**
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Prof. Jurij Franc Tasič

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**Centre for Networking Infrastructure (CNI)**
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*Tomaž Fatur, M. Sc.*
**Centre for Knowledge Transfer in Information Technologies (CT-3)**
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*Prof. Igor Jenčič*

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**National Centre for Microstructure and Surface Analysis**
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**Microanalytical Instrumental Centre (MIC)**
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*Prof. Janez Dolinšek*

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*Founders:*
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National Institute of Chemistry
Lek
SKB Bank
Technological
Development Fund of RS
Iskra Sistemi
IskraTel
**Jožef Stefan Institute**

### ERICo Velenje Ecological Research Institute

*Founders:*
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Velenje Lignite Mine
Electro - Machine Equipment, Velenje
**Jožef Stefan Institute**

### Nova Gorica Polytechnic

*Founders:*
Nova Gorica Municipality
Ajdovščina Municipality
Scientific Research Centre of the Slovenian Academy of Sciences and Arts, Ljubljana
**Jožef Stefan Institute**

### Jožef Stefan International Postgraduate School

*Founders:*
Gorenje, Velenje
Kolektor Group, Idrija
Salonit, Anhovo
Slovenian Insurance Association, Ljubljana
**Jožef Stefan Institute**

### Technology Centres

**Technology Centre for Production Automation, Robotics and Informatics (ARI)**

**Security Technology Competence Centre (SETCCE)**

**Technology Centre for Circuits, Components, Materials, Technologies and Equipment for Electrotechnic (TC SEMTO)**

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**Prof. Jadran Lenarčič** *(since 3. 7. 2005)*
Prof. Vito Turk *(until 2. 7. 2005)*

### Counsellors

**Prof. Peter Prelovšek** *(since 3. 7. 2005)*
**Prof. Jurij Franc Tasič** *(since 3. 7. 2005)*

### Assistant Directors

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Prof. Peter Stegnar *(until 2. 7. 2005)*

### Adviser

**Borut Lavrič, B. Iur.**

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**Prof. Peter Prelovšek**, *Deputy President*
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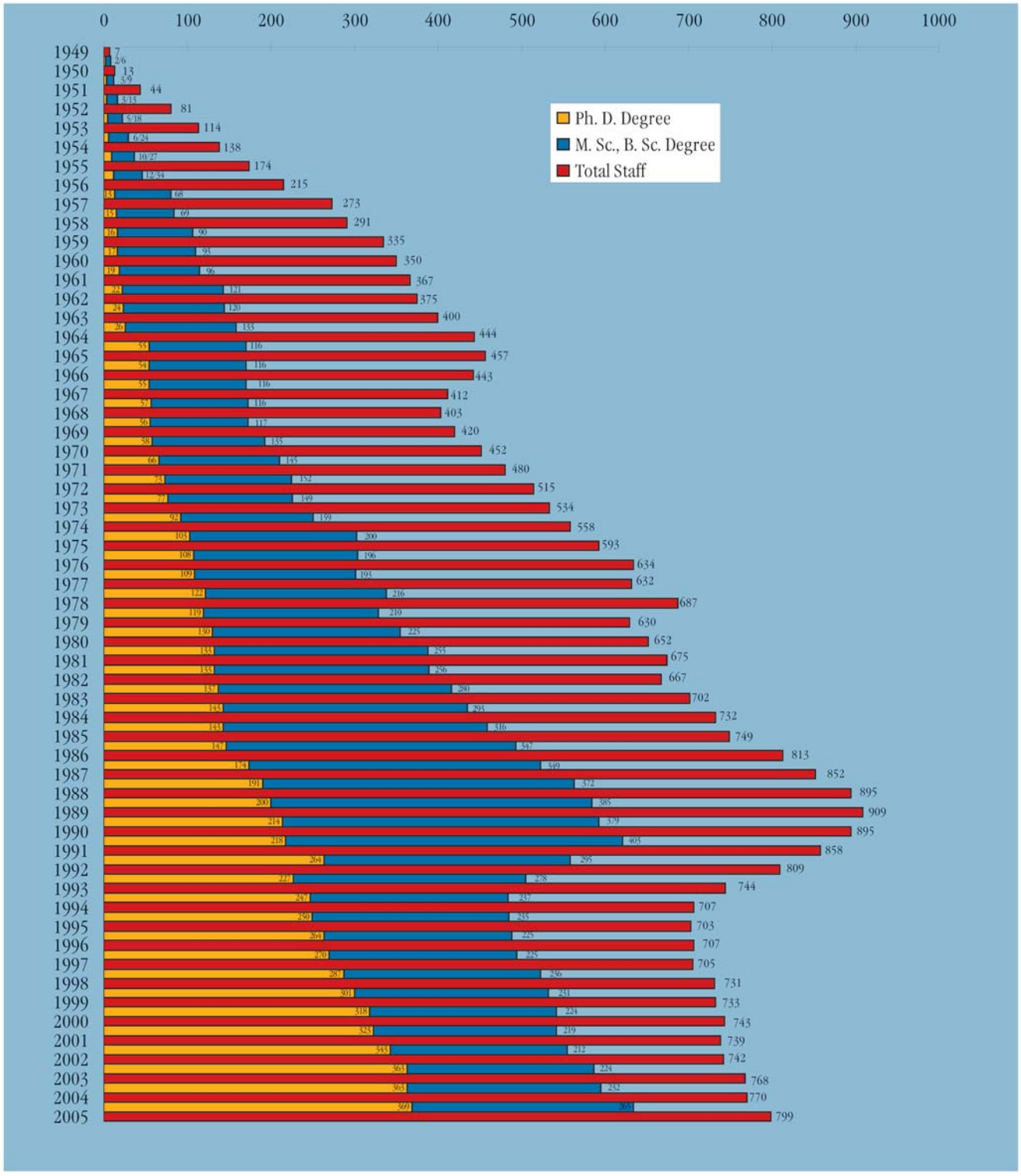
**Prof. Danilo Suvorov**
**Prof. Vito Turk**
**Prof. Boris Žemva**

# STAFF QUALIFICATIONS

## 1949-2005



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**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)

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**Prof. Andrej Župančič**, Slovenian Academy of Sciences and Arts, Ljubljana, Slovenia


*Statue of Milan Osredkar (1919-2003), honorary member and former Director of the JSI, unveiled on 24. 03. 2005*

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**Prof. Thomas Walcher**, Universität Mainz, Mainz, Germany

# INTERNATIONAL COOPERATION AGREEMENTS

***Cooperation agreements signed in 2005 between the Jožef Stefan Institute and:***

1. The NANO Systems Institute - National Core Research Center (NSI-NCRC), Republic of Korea
2. WaveTech A/S (WT), Stavanger, Norway
3. The Norwegian Computing Center (NR), Norway
4. Semantix Information Technologies S. A., Athens, Greece
5. Atheris Laboratories, Plan-les-Ouates, Switzerland
6. The Liaoning Cancer Hospital, Shenyang, PR China
7. University of Siena, PhD School in "Environmental Science and Technology", c/o Department of Environmental Science "G. Sarfatti", Siena, Italy
8. Atomic Energy Commission CEA, National Institute for Nuclear Sciences and Technology (CEA-INSTN), Gif-Sur-Yvette, France

# INTERNATIONAL COOPERATION

| Multilateral international cooperation | No. of projects |
|---|---|
| 6. FP (LIFESCIHEALTH, IST, NMP, AERO, TREN, SPACE, FOOD, ENERGY, TRANSPORT, GLOBAL, CITIZENS, SSP, NEST, SME, INCO, ERA-NET, MOBILITY, INFRASTRUCTURES, SCIENCE AND SOCIETY, RESEARCH/INNOVATION POLICIES) | 52 |
| 6. FP - EURATOM | 12 |
| 5. FP (QoL, IST, GROWTH, EESD, INCO, IPS, IHP) | 24 |
| 5. FP - EURATOM | 1 |
| IEE | 7 |
| LEONARDO DA VINCI | 1 |
| SOCRATES / MINERVA | 2 |
| EUREKA | 4 |
| COST | 20 |
| PHARE | 1 |
| NATO (SfP, CLG, CNR, RIG) | 8 |
| IAEA | 13 |
| ESF | 1 |
| INTERREG III B, C | 3 |
| OTHERS (DELPHI, HERA-B, ATLAS, CERN RD-39, CERN RD-50, BELLE, ICARUS, CIMA, ICGEB, CAMP, IRE, UNESCO-ROSTE) | 12 |
| **TOTAL** | **161** |

| Bilateral cooperation | No. of projects |
|---|---|
| Argentina | 1 |
| Austria | 12 |
| Belgium | 1 |
| Czech Republic | 4 |
| Finland | 3 |
| France (PROTEUS - 8) | 9 |
| Greece | 13 |
| Croatia | 21 |
| Italy | 17 |
| Japan | 12 |
| China | 6 |
| Korea | 2 |
| Hungary | 3 |
| Macedonia | 4 |

| Bilateral cooperation | No. of projects |
|---|---|
| Germany | 3 |
| The Netherlands | 1 |
| Poland | 3 |
| Portugal | 5 |
| Romania | 3 |
| Russia | 2 |
| Serbia and Montenegro | 17 |
| Spain | 3 |
| Turkey | 4 |
| Ukraine | 2 |
| United Kingdom (PSP - 2) | 3 |
| USA | 21 |
| **TOTAL** | **175** |

# FORMAL DELEGATIONS AND VISITORS

*Delegation of CEA (Commissariat à l'Energie Atomique), Paris, France*
January 4–7, 2005

**H. E. Mr. Thomas B. Robertson**, the Ambassador of the United States of America
January 19, 2005

*Delegation of the Cemagref, France:*
**Prof. Patric Lavarde**, Director General
**Dr. Pierrick Givone**, Deputy Scientific Director
**Dr. Raoul Mille**, International Affairs
**Mrs. Julienne Roux**, European and International Affairs Office
February 4, 2005

*Delegation of the Ministry of Science and Technology, State of Israel:*
**Mrs. Tali Rosenbaum**, Director General
**Mr. Ran Ichay**, Director; Division for International Relations
May 25, 2005

**Mr. Erwan Fouéré**, Head of the Representation of the European Commission in Slovenia
May 27, 2005

*Delegation of the Federal Department of Home Affairs, Swiss Confederation:*
**H. E. Mr. Charles Kleiber**, Secretary of State, State Secretariat for Education and Research
**H. E. Mr. Paul Koller**, Ambassador of Swiss Confederation in Slovenia
**Mr. Jürg Burri**, Science Counsellor, Swiss Mission to the EU, Brussels
**Mr. Jürg Siegenthaler**, Counsellor at the Embassy of Switzerland in Slovenia
May 30, 2005

*Delegation of Slovenian Army*
May 31, 2005

**H. E. Mr. Tim Simmons**, Ambassador of the United Kingdom of Great Britain and Northern Ireland
June 20, 2005

**H. E. Mr. Tomáš Szunyog**, Ambassador of the Czech Republic
**Mrs. Věra Pořízová**, Deputy Ambassador
June 29, 2005

*Delegations of the representatives of the Parliament of the Republic of Macedonia and Republic of Slovenia*
**Mrs. Sonja Lepitkova**, President of the Commission for Education, Science and Sport
**Mrs. Slavica Grkovska**
**Mr. Gjorgi Orovčanec**
**Mr. Kiro Dojčinoski**, President of the Commission for culture
**Mr. Huseini Huseindževat**
**Mrs. Lenče Gligorovska**, Counsellor at the Commission for Education, Science and Sport
**Rudi Moge**, President of the Committee for Higher Education, Science and Technology Development, National Assembly, Republic of Slovenia

**Mr. Uroš Pirnat**, Secretary of the Committee
September 22, 2005

**Mrs. Agueda Menvielle**, Directress, Direction of the International Relations, Secretariat of Science, Technology and Productive Innovations, Republic of Argentina
September 27, 2005

*Delegation of Joanneum Research, Graz, Austria:*
**Prof. Bernhard Pelzl**, Scientific Manager Director
**Mr. Helmut Wiedenhofer**, Tech. Transfer and Project Manager
**Dr. Wolfgang Waldhauser**, Leoben Laser Centre
**Dr. Erwin Kubista**, Institute of Applied Systems Technology
September 28, 2005

**Dr. Janez Potočnik**, EU Commissioner for Science and Research
October 10, 2005

**Dr. Suzanne Iacono**, Acting Deputy Assistant Director for Computer and Information Science and Engineering, NSF
**Dr. Mark Suskin**, Head of NSF Europe Office, Paris
October 19, 2005

*Delegation of the University of Primorska, Koper, Slovenia*:
**Prof. Lucija Čok**, Rector
**Prof. Andrej Brodnik**, Vice-Rector
**Prof. Milan Bufon**, Vice-Rector
**Prof. Rado Pišot**, Dean, Faculty of Education Koper (PFE)
**Prof. Darko Darovec**, Director of Science and Research Centre Koper (ZRS) and Deputy Dean of Faculty of Humanities Koper (FHŠ)
**Prof. Boris Kryštufek**, Institute of Biodiversal Studies ZRS
**Prof. Tomaž Pisanski**, Director of Primorska Institute of Natural Sciences and Technology (PINT)
**Mrs. Darja Radič**, Head of Turistica – College of Tourism Portorož
**Prof. Dragan Marušič**, Coordinator of the NAMA
October 21, 2005

*Delegation of the University of Ljubljana and Deans of Faculties:*
**Prof. Andreja Kocijančič**, Rector
**Prof. Julijana Kristl**, Vice-Rector
**Prof. Peter Maček**, Vice-Rector
**Prof. Ivan Svetlik**, Vice-Rector
**Prof. Jure Zupan**, Minister for Higher Education, Science and Technology
**Dr. Franci Demšar**, Director of the Slovenian Research Agency (ARRS)
November 10, 2005

*Meeting with managers of Slovenia ( 120 persons)*
**Prof. Jure Zupan**, Minister for Higher Education, Science and Technology
**Andrej Vizjak, M. Sc.**, Minister of the Economy
November 18, 2005

**Prof. Andrew Blaza**, Imperial College London
**Mr. Hermann Froehlich**, Boehringer Ingelheim Fonds
November 22, 2005

**H. E. Adi Rosenfeld**, Honorary Consul of the Republic of Slovenia in Israel
November 28, 2005

*Delegation of the Cypriot Researchers, Cyprus:*
**Dr. Andreas Hadjisavva**, Cyprus Institute of Neurology and Genetics
**Dr. George Georgiades**, GG Dedalos Technology Services
**Dr. Andreas Kyprianou**, University of Cyprus, Department of Mechanical and Manufacturing Engineering
**Dr. Antonis Londos**, Friderick Institute of Technology, Mechanical Engineering
**Dr. Vasilis Promponas**, University of Cyprus, Department of Biological Sciences
**Dr. Rebecca Kokkinofta**, State General Laboratory
December 12, 2005

# 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**, Nova Gorica Polytechnic
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. **Asst. Prof. Dean Cvetko**, University of Ljubljana, Faculty of Mathematics and Physics
7. **Prof. Bruno Cvikl**, University of Maribor, Faculty of Civil Engineering
8. **Prof. Mojca Čepič**, University of Ljubljana, Faculty of Education
9. **Prof. Martin Čopič**, University of Ljubljana, Faculty of Mathematics and Physics
10. **Prof. Tadej Dolenec**, University of Ljubljana, Faculty of Natural Sciences and Technology
11. **Asst. Prof. Marko Dolinar**, University of Ljubljana, Faculty of Chemistry and Chemical Technology
12. **Prof. Janez Dolinšek**, University of Ljubljana, Faculty of Mathematics and Physics
13. **Prof. Irena Drevenšek Olenik**, University of Ljubljana, Faculty of Mathematics and Physics
14. **Prof. Mihael Drofenik**, University of Maribor, Faculty of Chemistry and Chemical Engineering
15. **Prof. Svetlana Fajfer**, University of Ljubljana, Faculty of Mathematics and Physics
16. **Prof. Nenad Funduk**, University of Ljubljana, Faculty of Medicine
17. **Prof. Bojan Golli**, University of Ljubljana, Faculty of Education
18. **Asst. Prof. Boštjan Golob**, University of Ljubljana, Faculty of Mathematics and Physics
19. **Prof. Radomir Ilić**, University of Maribor, Faculty of Civil Engineering
20. **Asst. Prof. Borut Paul Kerševan**, University of Ljubljana, Faculty of Mathematics and Physics
21. **Prof. Alojzij Franc Kodre**, University of Ljubljana, Faculty of Mathematics and Physics
22. **Asst. Prof. Samo Korpar**, University of Maribor, Faculty of Chemistry and Chemical Engineering
23. **Prof. Janko Kos**, University of Ljubljana, Faculty of Pharmacy
24. **Prof. Samo Kralj**, University of Maribor, Faculty of Education
25. **Prof. Peter Križan**, University of Ljubljana, Faculty of Mathematics and Physics
26. **Prof. Brigita Lenarčič**, University of Ljubljana, Faculty of Chemistry and Chemical Technology
27. **Prof. Andrej Likar**, University of Ljubljana, Faculty of Mathematics and Physics
28. **Prof. Marko Mikuž**, University of Ljubljana, Faculty of Mathematics and Physics
29. **Prof. Igor Muševič**, University of Ljubljana, Faculty of Mathematics and Physics
30. **Prof. Slavko Pečar**, University of Ljubljana, Faculty of Pharmacy
31. **Asst. Prof. Igor Poberaj**, University of Ljubljana, Faculty of Mathematics and Physics
32. **Prof. Rudolf Podgornik**, University of Ljubljana, Faculty of Mathematics and Physics
33. **Asst. Prof. Tomaž Podobnik**, University of Ljubljana, Faculty of Mathematics and Physics
34. **Asst. Prof. Dušan Ponikvar**, University of Ljubljana, Faculty of Mathematics and Physics
35. **Prof. Peter Prelovšek**, University of Ljubljana, Faculty of Mathematics and Physics
36. **Prof. Anton Ramšak**, University of Ljubljana, Faculty of Mathematics and Physics
37. **Prof. Metka Renko**, University of Ljubljana, Faculty of Chemistry and Chemical Technology
38. **Prof. Jože Rugelj**, University of Ljubljana, Faculty of Education
39. **Prof. Janez Seliger**, University of Ljubljana, Faculty of Mathematics and Physics
40. **Prof. Aleš Stanovnik**, University of Ljubljana, Faculty of Electrical Engineering
41. **Prof. Janez Stepišnik**, University of Ljubljana, Faculty of Mathematics and Physics
42. **Prof. Saša Svetina**, Academician, University of Ljubljana, Faculty of Medicine
43. **Asst. Prof. Simon Širca**, University of Ljubljana, Faculty of Mathematics and Physics
44. **Prof. Žiga Šmit**, University of Ljubljana, Faculty of Mathematics and Physics
45. **Prof. Borut Štrukelj**, University of Ljubljana, Faculty of Pharmacy
46. **Asst. Prof. Ljupčo Todorovski**, University of Ljubljana, Faculty of Public Administration
47. **Asst. Prof. Tanja Urbančič**, Nova Gorica Polytechnic
48. **Asst. Prof. Nataša Vaupotič**, University of Maribor, Faculty of Education
49. **Prof. Danilo Zavrtanik**, Nova Gorica Polytechnic
50. **Prof. Marko Zgonik**, University of Ljubljana, Faculty of Mathematics and Physics
51. **Asst. Prof. Primož Ziherl**, University of Ljubljana, Faculty of Mathematics and Physics
52. **Prof. Marko Andrej Zupan**, University of Ljubljana, Faculty of Chemistry and Chemical Technology
53. **Prof. Boštjan Žekš**, Academician, University of Ljubljana, Faculty of Medicine
54. **Prof. Slobodan Žumer**, University of Ljubljana, Faculty of Mathematics and Physics

### Assistants

1. **Dr. Marko Bračko**, University of Maribor, Faculty of Chemistry and Chemical Engineering
2. **Dr. Branko Kavšek**, University of Primorska, Koper
3. **Dr. Marijan Maček**, University of Ljubljana, Faculty of Electrical Engineering
4. **Dr. Tomaž Mertelj**, University of Ljubljana, Faculty of Mathematics and Physics
5. **Dr. Saša Prelovšek Komelj**, University of Ljubljana, Faculty of Mathematics and Physics
6. **Dr. Tomaž Rejc**, University of Ljubljana, Faculty of Mathematics and Physics
7. **Dr. Barbara Rovšek**, University of Ljubljana, Faculty of Mathematics and Physics
8. **Dr. Lea Spindler**, University of Maribor, Faculty of Mechanical Engineering
9. **Dr. Darko Veberič**, Nova Gorica Polytechnic
10. **Dr. Vera Županski**, University of Ljubljana, Faculty of Chemistry and Chemical Technology

## PART TIME FACULTY MEMBERS

### Professors

1. **Prof. Robert Blinc**, Academician, University of Ljubljana, Faculty of Mathematics and Physics, Jožef Stefan International Postgraduate School, Ljubljana
2. **Asst. Prof. Vid Bobnar**, Jožef Stefan International Postgraduate School, Ljubljana
3. **Prof. Marko Bohanec**, University of Maribor, Faculty of Organisational Sciences, University of Ljubljana, Faculty of Public Administration and Jožef Stefan International Postgraduate School, Ljubljana
4. **Prof. Vladimir Cindro**, University of Ljubljana, Faculty of Natural Sciences and Technology
5. **Prof. Leon Cizelj**, University of Ljubljana, Faculty of Mathematics and Physics
6. **Asst. Prof. Miran Čeh**, University of Ljubljana, Faculty of Chemistry and Chemical Technology and Jožef Stefan International Postgraduate School, Ljubljana
7. **Asst. Prof. Marko Čepin**, University of Ljubljana, Faculty of Electrical Engineering
8. **Prof. Milan Čerček**, University of Maribor, Faculty of Civil Engineering
9. **Asst. Prof. Marko Debeljak**, Nova Gorica Polytechnic
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12. **Prof. Borka Džonova Jerman Blažič**, University of Ljubljana, Faculty of Economics, University of Maribor, Faculty of Criminal Justice and Security
13. **Asst. Prof. Tomaž Erjavec**, University of Ljubljana, Faculty of Arts and Jožef Stefan International Postgraduate School, Ljubljana
14. **Asst. Prof. Andrej Filipčič**, Nova Gorica Polytechnic
15. **Asst. Prof. Bogdan Filipič**, University of Ljubljana, Faculty of Mechanical Engineering, Faculty of Computer and Information Science, Nova Gorica Polytechnic, Jožef Stefan International Postgraduate School, Ljubljana
16. **Prof. Matjaž Gams**, University of Ljubljana, Faculty of Economics, Faculty of Computer and Information Science, Faculty of Arts, School of Business and Management, Novo Mesto, Jožef Stefan International Postgraduate School, Ljubljana
17. **Prof. Bogdan Glumac**, University of Maribor, Faculty of Civil Engineering, University of Ljubljana, Faculty of Mathematics and Physics
18. **Prof. Milena Horvat**, Jožef Stefan International Postgraduate School, Ljubljana
19. **Prof. Igor Jenčič**, University of Maribor, Faculty of Civil Engineering, University of Ljubljana, Faculty of Mathematics and Physics
20. **Asst. Prof. Zvonka Jeran**, University of Ljubljana, Biotechnical Faculty
21. **Asst. Prof. Đani Juričić**, Nova Gorica Polytechnic
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24. **Prof. Monika Kapus Kolar**, University of Maribor, Faculty of Electrical Engineering and Computer Science
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32. **Prof. Igor Križaj**, University of Ljubljana, Faculty of Chemistry and Chemical Technology, Biotechnical Faculty, Jožef Stefan International Postgraduate School, Ljubljana
33. **Asst. Prof. Zdravko Kutnjak**, University of Ljubljana, Faculty of Mathematics and Physics and Faculty of Mechanical Engineering, Jožef Stefan International Postgraduate School, Ljubljana
34. **Prof. Gojmir Lahajnar**, University of Ljubljana, Biotechnical Faculty
35. **Prof. Nada Lavrač**, University of Ljubljana, Faculty of Social Sciences, Nova Gorica Polytechnic, Jožef Stefan International Postgraduate School, Ljubljana
36. **Prof. Jadran Lenarčič**, University of Ljubljana, Faculty of Electrical Engineering, Nova Gorica Polytechnic
37. **Asst. Prof. Darko Makovec**, University of Maribor, Faculty of Chemistry and Chemical Engineering and Faculty of Medicine, Jožef Stefan International Postgraduate School, Ljubljana
38. **Asst. Prof. Igor Mandić**, University of Ljubljana, Faculty of Electrical Engineering
39. **Prof. Borut Mavko**, University of Ljubljana, Faculty of Mathematics and Physics
40. **Prof. Igor Mekjavić**, University of Portsmouth, Institute of Biomedical and Biomolecular Sciences, Portsmouth, United Kingdom
41. **Prof. Dragan Dragoljub Mihailović**, University of Ljubljana, Faculty of Mathematics and Physics and Jožef Stefan International Postgraduate School
42. **Asst. Prof. Radmila Milačič**, University of Ljubljana, Faculty of Chemistry and Chemical Technology and Jožef Stefan International Postgraduate School,
43. **Asst. Prof. Dunja Mladenić**, Jožef Stefan International Postgraduate School
44. **Prof. Franc Novak**, University of Maribor, Faculty of Electrical Engineering and Computer Science and Jožef Stefan International Postgraduate School, Ljubljana
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46. **Prof. Albert Prodan**, Jožef Stefan International Postgraduate School, Ljubljana
47. **Prof. Jože Pungerčar**, University of Ljubljana, Faculty of Chemistry and Chemical Technology
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50. **Asst. Prof. Maja Remškar**, Jožef Stefan International Postgraduate School
51. **Prof. Milan Valter Schara**, University of Ljubljana, Faculty of Chemistry and Chemical Technology
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53. **Asst. Prof. Marko Starič**, University of Ljubljana, Faculty of Mathematics and Physics
54. **Prof. Peter Stegnar**, Jožef Stefan International Postgraduate School, Ljubljana

55. **Prof. Stanislav Strmčnik**, University of Ljubljana, Faculty of Electrical Engineering, Nova Gorica Polytechnic
56. **Prof. Danilo Suvorov**, University of Ljubljana, Faculty of Chemistry and Chemical Technology and Faculty of Mathematics and Physics, Jožef Stefan International Postgraduate School, Ljubljana
57. **Asst. Prof. Jurij Šilc**, Jožef Stefan International Postgraduate School, Ljubljana
58. **Asst. Prof. Janez Štrancar**, Jožef Stefan International Postgraduate School
59. **Asst. Prof. Iztok Tiselj**, University of Ljubljana, Faculty of Mathematics and Physics, University of Maribor, Faculty of Logistics
60. **Dr. Mihael Gabrijel Tomšič**, Jožef Stefan International Postgraduate School
61. **Asst. Prof. Denis Trček**, University of Ljubljana, Faculty of Computer and Information Science
62. **Asst. Prof. Andrej Trkov**, University of Ljubljana, Faculty of Mathematics and Physics
63. **Asst. Prof. Roman Trobec**, University of Salzburg, Department of Scientific Computing, Salzburg, Austria and University of Ljubljana, Faculty of Computer and Information Science
64. **Asst. Prof. Boris Turk**, University of Ljubljana, Biotechnical Faculty, Jožef Stefan International Postgraduate School, Ljubljana
65. **Asst. Prof. Dušan Turk**, University of Ljubljana, Faculty of Chemistry and Chemical Technology and Faculty of Medicine, Jožef Stefan International Postgraduate School, Ljubljana
66. **Prof. Vito Turk**, University of Ljubljana, Biotechnical Faculty and Faculty of Chemistry and Chemical Technology, Jožef Stefan International Postgraduate School, Ljubljana, Nova Gorica Polytechnic
67. **Asst. Prof. Janja Vaupotič**, University of Ljubljana, Faculty of Medicine, Nova Gorica Polytechnic
68. **Asst. Prof. Damir Vrančić**, University of Maribor, Faculty of Logistics
69. **Prof. Anton Zalar**, University of Ljubljana, Faculty of Natural Sciences and Technology and University of Maribor, Faculty of Electrical Engineering and Computer Science, Jožef Stefan International Postgraduate School, Ljubljana
70. **Asst. Prof. Boštjan Zalar**, University of Ljubljana, Faculty of Mathematics and Physics and Biotechnical Faculty, Jožef Stefan International Postgraduate School, Ljubljana
71. **Asst. Prof. Marko Zavrtanik**, Nova Gorica Polytechnic
72. **Prof. Aleksander Zidanšek**, University of Maribor, Faculty of Education, Jožef Stefan International Postgraduate School, Ljubljana
73. **Prof. Boris Žemva**, University of Ljubljana, Faculty of Chemistry and Chemical Technology, Jožef Stefan International Postgraduate School, Ljubljana
74. **Asst. Prof. Matjaž Žitnik**, University of Ljubljana, Faculty of Mathematics and Physics
75. **Asst. Prof. Tomi Živko**, University of Ljubljana, Faculty of Natural Sciences and Technology

## Assistants

1. **Dr. Milan Ambrožič**, University of Ljubljana, Faculty of Mathematics and Physics, Faculty of Computer and Information Science and Faculty of Education
2. **Zoran Arsov, B. Sc.**, University of Ljubljana, Faculty of Mathematics and Physics
3. **Matej Batič, B. Sc.**, Nova Gorica Polytechnic
4. **Gregor Bavdek, B. Sc.**,University of Ljubljana, Faculty of Mathematics and Physics
5. **Uroš Benko, B. Sc.**, University of Maribor, Faculty of Logistics
6. **Dr. Slavko Bernik**, Jožef Stefan International Postgraduate School, Ljubljana
7. **Dr. Ilija Bizjak**, University of Ljubljana, Faculty of Pharmacy
8. **Dr. Klemen Bučar,** University of Ljubljana, Faculty of Mathematics and Physics
9. **Dr. Marjetka Conradi**, University of Ljubljana, Veterinary Faculty
10. **Dr. Janko Černetič**, University of Ljubljana, Faculty of Electrical Engineering
11. **Dr. Goran Dražič**, Jožef Stefan International Postgraduate School, Ljubljana
12. **Saša Fratina, B. Sc.**, University of Ljubljana, Faculty of Natural Sciences and Technology
13. **Dr. Dušan Gabrijelčič**, University of Maribor, Faculty of Criminal Justice and Security
14. **Dr. Andrej Gorišek**, University of Ljubljana, Faculty of Mathematics and Physics, Faculty of Natural Sciences and Technology
15. **Dr. Nadja Hvala,**, Nova Gorica Polytechnic
16. **Dr. Peter Jeglič**, University of Ljubljana, Faculty of Chemistry and Chemical Technology and Faculty of Mathematics and Physics
17. **Dr. Martin Klanjšek**, University of Ljubljana, Faculty of Mathematics and Physics
18. **Dr. Tomaž Klobučar**, University of Maribor, Faculty of Criminal Justice and Security
19. **Dr. Matej Komelj**, University of Ljubljana, Faculty of Mathematics and Physics
20. **Dr. Barbara Koroušić Seljak**, Jožef Stefan International Postgraduate School
21. **Dr. Kristoffer Krnel**, University of Ljubljana, Biotechnical Faculty
22. **Andrija Lebar**, University of Ljubljana, Biotechnical Faculty
23. **Dr. Matej Lipoglavšek**, University of Ljubljana, Faculty of Mathematics and Physics
24. **Andrej Mihelič, B. Sc.,** University of Ljubljana, Faculty of Mathematics and Physics
25. **Dr. Alenka Mertelj**, University of Ljubljana, Faculty of Mathematics and Physics
26. **Dr. Nives Ogrinc**, University of Ljubljana, Faculty of Chemistry and Chemical Technology
27. **Dr. Rok Pestotnik**, University of Ljubljana, Faculty of Mathematics and Physics, University of Maribor, Faculty of Chemistry and Chemical Engineering
28. **Dr. Janko Petrovčič**, University of Ljubljana, Faculty of Electrical Engineering
29. **Dr. Aleksander Rečnik**, University of Ljubljana, Faculty of Natural Sciences and Technology, Jožef Stefan International Postgraduate School, Ljubljana
30. **Dr. Igor Sega**, University of Ljubljana, Faculty of Mathematics and Physics
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32. **Dr. Andrej Studen**, University of Ljubljana, Faculty of Mathematics and Physics
33. **Dr. Miha Škarabot**, University of Ljubljana, Faculty of Natural Sciences and Technology and Faculty of Mathematics and Physics
34. **Dr. Polona Umek**, Jožef Stefan International Postgraduate School, Ljubljana
35. **Dr. Mojca Vilfan**, University of Ljubljana, Faculty of Mathematics and Physics
36. **Dr. Boris Vodopivec**, University of Ljubljana, Faculty of Mathematics and Physics
37. **Dr. Andrej Zorko**, University of Ljubljana, Faculty of Natural Sciences and Technology and Faculty of Chemistry and Chemical Technology
38. **Anže Zupanc, B. Sc.**, University of Ljubljana, Faculty of Chemistry and Chemical Technology

# INSTITUTE COLLOQUIA

**Prof. Zoran Lj. Petrović**
Institut za fiziku, Zemun, Beograd, Serbia and Monte Negro
***Fundamental kinetic processes and applications of non-equilibrium plasmas: The activities of the Gaseous Electronics Laboratory***
February 11, 2005

**Prof. Igor Križaj**
Jožef Stefan Institute, Ljubljana, Slovenia
***Natural toxins, potential tools in biomedicine; How does presynaptically toxic phospolipase A2 work***
February 16, 2005

**Dr. Božidar Brudar**
International Center for Sustaninable Development, Ljubljana, Slovenia
***Interpretation of data by mathematical statistics***
February 23, 2005

**Prof. Igor Muševič**
Jožef Stefan Institute and Faculty of Mathematics and Physics, Ljubljana, Slovenia
***Structural forces in liquid crystals***
March 9, 2005

**Dr. Matjaž Mulej**
Faculty of Economics and Business, Universyity of Maribor, Maribor, Slovenia
***Complexity theory – which systems theory stream is it a part of?***
April 13, 2005

**Prof. Albert Díaz-Guilera**
Faculty of Physics, University of Barcelona, Barcelona, Spain
***Statistical mechanics of complex networks***
May 25, 2005

**Dr. Marcos Bavdaz**
European Space Research and Technology Centre - ESTEC, European Space Agency, Noordwijk, Nederland
***Space science and technological development at the European Space Agency (ESA)***
September 12, 2005

**Prof. Paul De Bièvre**
Kasterlee, Belgium
***The ongoing Redetermination of the Avogadro Constant and its Importance for Amount-of-Substance Measurements***
September 30, 2005

**Prof. Robert Huber**
Max Planck Institute of Biochemistry, Martinsried, Germany
***Immunoreceptor-antibody interactions: from basic science to application in medicine***
November 30, 2005

**Prof. Angus I. Kingon**
North Carolina State University, Raleigh, USA
***Finding Business Opportunities in Science and Technology: Whose Responsibility is it?***
December 20, 2005

# ART EXHIBITIONS AT THE JSI

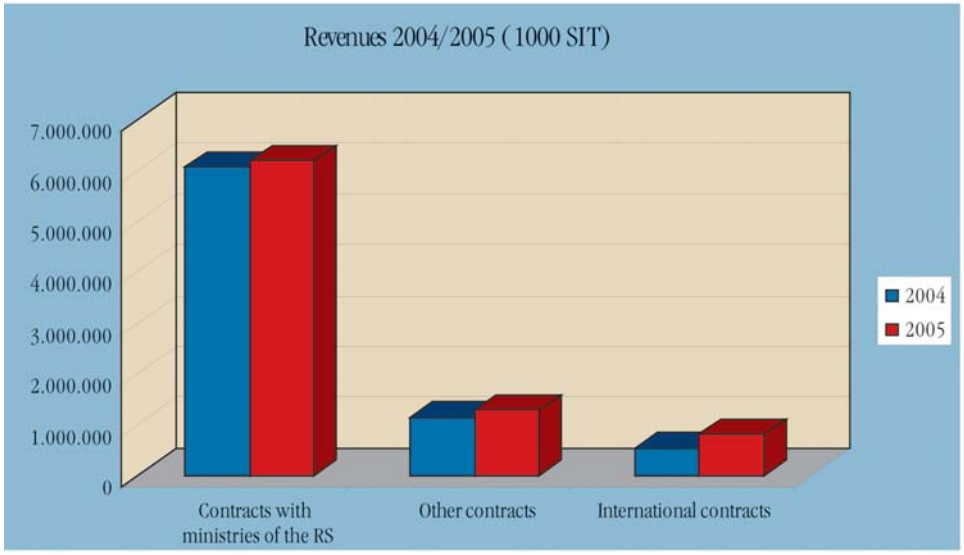
**Pia Zavrtanik,** January 24–March 17, 2005
**Milena Usenik,** March 22–May 26, 2005
**Tiziana di Fonzo,** May 30–September 15, 2005
**Darko Slavec,** September 19–November 10, 2005
**Nikolaj Vogel,** November 14–December 12, 2005
**Veljko Toman,** December 12, 2005–January 20, 2006

*Milena Usenik at the opening of exibition of her work*

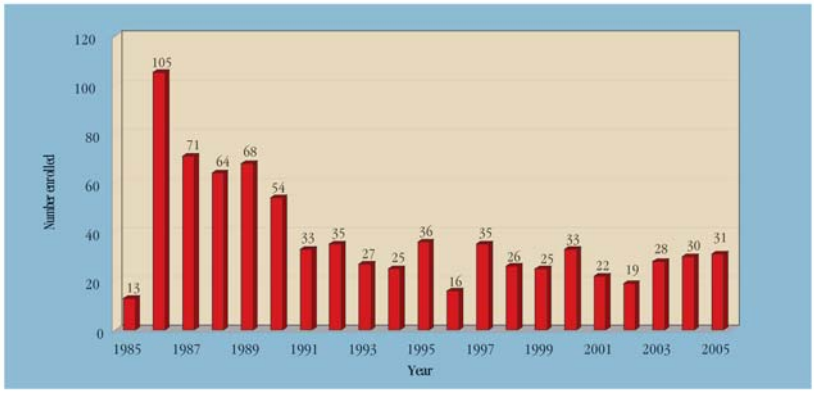
# FINANCING

## REVENUES JSI (1000 SIT) AND NUMBER OF PROJECTS

| | 2004 | 2005 | 2005/2004 | contrib. 2005 | No. of projects in the year 2005 |
|---|---|---|---|---|---|
| Contracts with ministries of the RS | 6.067.413 | 6.188.363 | 101,99 % | 74,70 % | 244 |
| Other contracts | 1.143.204 | 1.289.763 | 112,82 % | 15,57 % | 97 |
| International contracts | 546.666 | 806.500 | 147,53 % | 9,73 % | 336 |
| **TOTAL** | **7.757.283** | **8.284.626** | **106,80 %** | **100,00 %** | **677** |




# POSTGRADUATES FINANCED BY ARRS*




1985-2005

** ARRS - Slovenian Research Agency*

# JSI UNDERGRADUATE SCHOLARSHIPS

1977-2005

| Year | FMF | | FKKT | FFA | FDV | BF | FE and FRI | FS | EF | FG and FERI | MF | NGP | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Physics | Mathematics | | | | | | | | | | | |
| 1977 | 18 | 9 | 19 | | | | 5 | 2 | 1 | | | | 54 |
| 1978 | 24 | 8 | 22 | | | | 6 | 2 | | | | | 62 |
| 1979 | 26 | 8 | 22 | | | | 8 | 2 | | | | | 66 |
| 1980 | 20 | 5 | 19 | | | | 8 | 1 | | | | | 53 |
| 1981 | 15 | 6 | 11 | | | | 10 | 1 | 1 | | | | 44 |
| 1982 | 12 | 2 | 7 | | | | 13 | 1 | 1 | | | | 36 |
| 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 | 1 | 1 | | | | 71 |
| 1989 | 26 | 6 | 10 | 2 | | 1 | 19 | 1 | | 1 | | | 66 |
| 1990 | 26 | 5 | 11 | | | 2 | 25 | | | 1 | | | 70 |
| 1991 | 23 | 2 | 9 | 2 | | 2 | 24 | | | 1 | | | 63 |
| 1992 | 22 | 3 | 16 | 1 | | 3 | 17 | | | | | | 62 |
| 1993 | 21 | 1 | 15 | 1 | | 3 | 13 | | | | | | 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 | | | 2 | 1 | 2 | 42 |
| 2005 | 3 | | 12 | | 1 | 2 | 19 | | | 2 | | 1 | 40 |
| TOTAL | 368 | 87 | 331 | 6 | 1 | 43 | 369 | 15 | 4 | 12 | 2 | 3 | 1241 |

**FMF** Faculty of Mathematics and Physics, University of Ljubljana
**FKKT** Faculty of Chemistry and Chemical Technology, University of Ljubljana
**FFA** Faculty of Pharmacy, University of Ljubljana
**FDV** Faculty of Social Sciences, 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
**FS** Faculty of Mechanical Engineering, University of Ljubljana
**EF** Faculty of Economics, University of Ljubljana
**MF** Faculty of Medicine, University of Ljubljana
**FG** Faculty of Civil Engineering, University of Maribor
**FERI** Faculty of Electrical Engineering and Computer Science, University of Maribor
**NGP** Nova Gorica Polytechnic

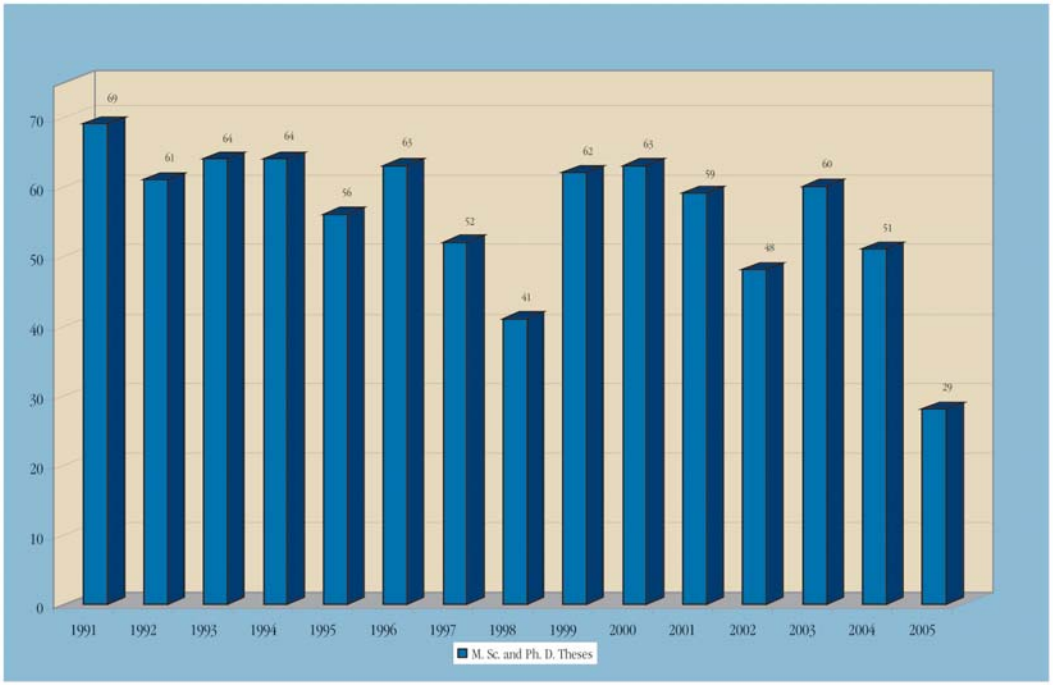
# COMPLETED THESES

## UNTIL 2005

| 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 |
| 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 |
| TOTAL | 714 | 815 | 1529 |

# PUBLICATIONS

## 1991-2005

# REVIEW OF PUBLICATIONS

## FOR 2005

| Department | Original Articles | Books | Patent Appl. and Grants | Theses |
|---|---|---|---|---|
| Department of Theoretical Physics (F-1) | 72 | 4 | | |
| Department of Low and Medium Energy Physics (F-2) | 83 | 1 | 1 | 1 |
| Department of Thin Films and Surfaces (F-3) | 25 | 2 | | |
| Department of Surface Engineering and Optoelectronics (F-4) | 35 | | 6 | 2 |
| Department of Solid State Physics (F-5) | 117 | 2 | 8 | 1 |
| Department for Complex Matter (F-7) | 43 | | 2 | 2 |
| Department of Reactor Physics (F-8) | 56 | | | |
| Department of Experimental Particle Physics (F-9) | 97 | | | 2 |
| Department of Inorganic Chemistry and Technology (K-1) | 28 | | | 1 |
| Department of Physical and Organic Chemistry (K-3) | 25 | | | 1 |
| Electronic Ceramics Department (K-5) | 45 | | 6 | 1 |
| Engineering Ceramics Department (K-6) | 13 | | | |
| Department for Nanostructured Materials (K-7) | 53 | | 1 | |
| Department for Advanced Materials (K-9) | 49 | | 6 | |
| Department of Biochemistry and Molecular Biology (B) | 45 | | 1 | 3 |
| Department of Environmental Sciences (O-2) | 107 | | | 3 |
| Department of Automation, Biocybernetics and Robotics (E-1) | 35 | | | 2 |
| Department of Systems and Control (E-2) | 35 | 1 | | |
| Laboratory for Open Systems and Networks (E-5) | 18 | | | 3 |
| Department of Communication Systems (E-6) | 31 | 3 | | 1 |
| Department of Computer Systems (E-7) | 14 | 4 | 1 | |
| Department of Knowledge Technologies (E-8) | 78 | 13 | | 2 |
| Department of Intelligent Systems (E-9) | 59 | 2 | | 2 |
| Department of Reactor Engineering (R-4) | 50 | | 1 | 1 |
| Energy Efficiency Centre (EEC) | 22 | | | 1 |
| Centre for Knowledge Transfer in Information Technologies (CT-3) | 5 | 1 | | |
| Milan Čopič Nuclear Training Centre (ICJT) | 5 | | | |
| Radiation Protection Unit (SVPIS) | 4 | | | |
| **TOTAL** | **1249** | **33** | **33** | **29** |

# AWARDS AND APPOINTMENTS

## AWARDS MADE TO JSI RESEARCHERS BY THE REPUBLIC OF SLOVENIA

### Zois Recognitions and Award of the Republic of Slovenia

**Asst. Prof. Dušan Turk**, Zois Award for excellent scientific achievements in structural biology

**Asst. Prof. Boštjan Zalar**, Zois Award for significant scientific contributions to the physics of condensed matter

## JSI AWARDS AND APPOINTMENTS

### The Jožef Stefan Golden Emblem Prize

***was awarded to the following for doctoral theses with high impact :***

**Dr. Martin Klanjšek**, Jožef Stefan Institute
*Physical properties of icosahedral aluminium-based quasicrystalline alloys*

**Dr. Jure Zupan**, Jožef Stefan Institute
*Chiral corrections in electroweak processes with heavy mesons*

**Dr. Marko Žnidarič**, University of Ljubljana, Faculty of Mathematics and Physics
*Stability of qauntum dynamics*

### The Jožef Stefan Roll of Honour

***was awarded to companies and institutions for successful scientific and technological cooperation with the Jožef Stefan Institute:***

**Lek, d. d., Ljubljana**
**Varsi, d. o. o., Ljubljana**

## INTERNATIONAL AWARDS TO JSI RESEARCHERS

**Dr. Marjetka Conradi**
Humboldt Research Fellowship, Alexander von Humboldt Foundation, Bonn, Germany

**Dr. Nina Daneu**
Humboldt Research Fellowship, Alexander von Humboldt Foundation, Bonn, Germany

**Asst. Prof. Bogdan Filipič**
Best presentation award at the COST 526 Final Working Group Meeting, Besançon, France, Project Management Committee
*The role of optimization methodologies and WG4 in COST 526*

**Dr. Peter Jeglič**
Pro Natura Award, Slovenian Foundation Pro Natura, Bled and German Foundation Boehringer Ingelheim Fonds

**Prof. Marija Kosec**
Society Award, MIDEM

**Dr. Aleš Premzl**
Pro Natura Award, Slovenian Foundation Pro Natura, Bled and German Foundation Boehringer Ingelheim Fonds

**Dr. Sašo Šturm**
Best Early Career Scientist Award, EDGE 2005, International EELS Workshop, Grundlsee, Austria
*Atomic Resolution HAADF-STEM Imaging and EELS Analysis of Ruddlesden-Popper Faults in the AO-doped $SrTiO_3$ ($A=Sr^{2+}$, $B_2^{2+}$)*

## AWARDS TO JSI RESEARCHERS BY SLOVENIAN INSTITUTIONS

**Dr. Zoran Arsov**
Best conference poster, Regional Biophysics Meeting 2005, Zreče, Slovenia

**Matej Kanduč**
Students Prešeren Award, University of Ljubljana, Faculty of Mathematics and Physics, Ljubljana, Slovenia
*Dynamical Two-particle Phenomena in Nanostructures*

*The winners of the Jožef Stefan Golden Emblem Prize*

**Jerneja Godnjavec**
Prešeren award for B. Sc. Thesis
*The influence of strontium addition on structure, microstructure and electrical properties of* $(K_{0.5}Na_{0.5})NbO_3$ *ceramics*

**Sašo Gyergyek**
Henkel Fund Reward for B. Sc. Thesis, Henkel Fund, Maribor, Slovenia
*Synthesis of some copper (II) metanoates with aminopyridine*

**Dr. Saša Jenko Kokalj**
Krka Award for Ph. D. Thesis
*Structural studies of oligomers and amyloid fibrils of stefins A and B*

**Špela Kunej**
1st Award, Student Poster Competition, IX. European Ceramic Society Conference and Exhibition, Portorož, Slovenia

**Mojca Mattiazzi**
Student Prešeren Award for B. Sc. Thesis
*In vitro interaction of secretory phospholipase A2 with recombinant yeast 14-3-3 proteins*

**Janko Petrovčič, Gregor Dolanc, Bojan Musizza** in cooperation with team members of the company Domel, Železniki, Slovenia
The Golden Award for Innovations 2004 awarded by The Chamber of Economy of Gorenjska Region, Kranj, Slovenia

**Barbara Petelin Visočnik**
Trimo research award, Trimo, d. d., Trebnje, Slovenia
*Introduction of Third Party Financing in Hospitals*

**Benjamin Podmiljšak**
Winning contribution of young scientists at the 13th Conference on Materials and Technologies, Portorož, Slovenia
*Ultra-Thin Sintered and Bonded Nd-Fe-B Magnets for MEMS Applications*

# PATENTS GRANTED

1. **Electromagnetic display panel**
   Milan Bavec, Franc Justin, Janez Ropret, Janez Pirš
   Patent no. 2004010, EP 1591985
2. **Method for fabrication of KNN($K_{0.5}Na_{0.5}NbO_3$) ceramics with high density**
   Janez Bernard, Barbara Malič, Janez Holc, Marija Kosec
   Patent no. 21798
3. **Solide phase synthesis of amidines and their derivatives and their use for formation of combinatorial libraries**
   Jožko Cesar, Slavko Pečar
   Patent no. 21559
4. **Method for fabrication of complex lead-based perovskites**
   Andrej Degen, Marija Kosec, Janez Holc, Barbara Malič, Silvo Drnovšek
   Patent no. 21797
5. **Preparation of Complex Perovskites by Mechanochemical Synthesis**
   Janez Holc, Barbara Malič, Silvo Drnovšek, Marija Kosec
   Patent no. 21556
6. **Ferroelectric Thick Films on Reactive Ceramics**
   Janez Holc, Silvo Drnovšek, Marko Hrovat, Marija Kosec
   Patent no. 21585
7. **Surface-Mountable Thick-Film Hybrid Module for Protection of a Telephone Line**
   Sandi Kocjan, Janez Gramc, Alojz Simončič, Darko Pavlin, Marina Santo Zarnik
   Patent no. 21770
8. **Procedure for evaluation of hybridoma cell fraction and cell products using confocal microscopy and autoclavable electrofusion cell**
   Marko Kreft, Sonja Grilc, Igor Poberaj, Helena Chowdhury Haque, Robert Zorec
   Patent no. 21661
9. **Chain drive train for bicycle or other vehicle with chain**
   Matjaž Leskovar
   Patent no. 9400377
10. **Triple resonance enhanced nuclear quadrupole resonance detection of TNT and other explosives**
    Janez Seliger, Robert Blinc, Tomaž Apih, Gojmir Lahajnar
    Patent no. 21715
11. **Low sinterable ceramics based on $Li_2O$-doped $(Ba,Sr)TiO_3$**
    Matjaž Valant, Danilo Suvorov
    Patent no. 21615
12. **Multilayer ceramic capacitors from dielectric ceramics based on silver tantalum and niobium**
    Christian Hoffmann, Helmut Sommariva, Danilo Suvorov, Matjaž Valant
    Patent no. DE 10042359.0
13. **Dielectric ceramic materials**
    Christian Hoffmann, Danilo Suvorov, Matjaž Valant
    Patent no. US 6956001 B2
14. **Method for plant protection against insects or nematodes by transformations with a nucleic acid encoding equistatin**
    Maarten Anthonie Jongsma, Borut Štrukelj, Brigita Lenarčič, Kristina Gruden, Vito Turk, Hendrik J. Bosch, Willem J. Johannes Stiekema
    Patent no. WO98/58068, US 6,681,578
15. **Permeameter for measuring magnetic properties at high temperatures**
    Paul J. McGuiness, Gregor Geršak, Spomenka Kobe
    Patent no. WO 2005/040842 A1
16. **Plasma Treatment for Purifying Copper or Nickel**
    Miran Mozetič, Uroš Cvelbar
    Patent no. PCT/WO 2005/098259 A2, DE C23G 5/00
17. **Method for producing a ceramic silver niobium tantalate body**
    Matjaž Valant, Danilo Suvorov, Christian Hoffmann, Helmut Sommariva
    Patent no. US 6,843,956 B2.
18. **Method and Device for Measuring of Ultrahigh Vacuum**
    Alenka Vesel, Miran Mozetič
    Patent no. 21714, PCT/WO2005/080932
19. **Electromagnetic display panel illumination**
    Janez Pirš, Silvija Pirš, Milan Bavec, Franc Justin, Silvano Mendizza, Janez Ropret
    Patent no. EP 1591984

# CENTRES OF EXCELLENCE

Research Centres of Excellence, a concept developed by the Ministry of Higher Education, Science and Technology and co-financed by the European Regional Development Fund, are a new form of cooperation between research institutes, academic institutions, and industry. Their main goal is the development of an innovative environment to facilitate the transfer, management, and development of new technologies in various priority areas of research and technology. For the period 2004-2006, the Jožef Stefan Institute has been chosen as the coordinator of four Centres of Excellence, with twenty R&D projects.

## Nanoscience and Nanotechnology

*Head: Prof. Dragan Dragoljub Mihailović*

*Project Activity Group:*

1. **Nanoelectronics and Nanotechnology Facilities**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partner:* LPKF, d. o. o., Zgornje Jezersko
2. **Synthesis of 1D Inorganic Nanostructures, Bionanostructures and Preparation of Composites**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* Termo, d. d.. Škofja Loka; Mo6, d. o. o., Ljubljana
3. **Characterisation on Nanometric Scale**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* Lek, d. d., Ljubljana; Acroni, d. o. o., Jesenice; Iskra Kondenzatorji, d. d., Semič; Eta Cerkno, d. o. o., Cerkno; Steklarna Hrastnik, d. d., Hrastnik ; Steklarna Rogaška, d. d., Rogaška Slatina
4. **Nanomaterials in Electrochemical Systems**
   *Leading institution:* National Institute of Chemistry, Ljubljana
   *Cooperating partners:* Atotech, d. d., Podnart; Iskra Tela, d. d., Ljubljana; Predilnica Litija, d. o. o., Litija
5. **Nanostructured Surfaces and Interfaces**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* HYB, d. o. o., Šentjernej; Balder, d. o. o., Ljubljana; Cinkarna Celje, d. d., Celje; HIDRIA-IP, d. o. o. - AET, d. o. o., Tolmin; Kolektor Pro, d. o. o., Idrija
6. **Synthesis of Nanoparticles and Nanocomposites**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* Belinka Belles, d. o. o., Ljubljana; Iskra Feriti, d. o. o., Ljubljana; Keko Oprema, d. o. o., Žužemberk; MS Production, Bled; Iskra Mehanizmi, d. d., Kropa

## Materials for the Next Generation Electronics and Other Coming Technologies

*Head: Prof. Marija Kosec*

*Project Activity Group:*

1. **Magnetic Materials and Intermetallic Alloys**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* Institute of Metals and Technology, Ljubljana; Magneti, d. d., Ljubljana; Iskra Feriti, d. o. o., Ljubljana; Kolektor Pro, d. o. o., Idrija
2. **Microstructures and Microsystems**
   *Leading institution:* University of Ljubljana, Faculty of Electrical Engineering, Ljubljana
   *Cooperating partners:* Iskra Tela, d. d., Ljubljana; Iskra Avtoelektrika, d. d., Nova Gorica
3. **New generation of Elements and Devices for Protection Against Transient Surges**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* Milan Vidmar Electric Power Research Institute, Ljubljana; Zavod TC SEMTO, Ljubljana; VARSI, d. o. o., Ljubljana; Iskra Zaščite, d. o. o., Ljubljana; University of Ljubljana, Faculty of Electrical Engineering, Ljubljana; Iskra Tela, d. d., Ljubljana
4. **Hybrid Materials and Structures**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* HIPOT-RR, d. o. o., Šentjernej; HYB, d. o. o., Šentjernej
5. **Complex Materials for New Technologies: From Soft Matter to Hard Coatings**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* Gorenje, d. d., Velenje; Balder, d. o. o., Ljubljana; University of Ljubljana, Faculty of Mathematics and Physics, Ljubljana; Institute for Mathematics, Physics and Mechanics in Ljubljana, Laboratory for NQR and weak magnetic fields, Ljubljana

## Environmental Technologies

*Head: Prof. Milena Horvat*

*Project Activity Group:*

1. **Biological Methods of Wastewater Treatment**
   *Leading institution:* University of Ljubljana, Faculty of Civil Engineering and Geodesy, Ljubljana
   *Cooperating partners:* University of Ljubljana; National Institute of Biology, Ljubljana; Domžale – Kamnik Wastewater Treatment Plant, d. o. o., Domžale; Institute of Physical Biology, Grosuplje; National Institute of Chemistry, Ljubljana; Komunalno podjetje Velenje, d. o. o., Velenje; Esotech, d. d., Velenje; Nova Gorica Polytechnic, Nova Gorica; Limnos – Company for Applied Ecology, d. o. o., Ljubljana
2. **Ecoremediation Technologies**
   *Leading institution:* University of Ljubljana, Biotechnical faculty, Ljubljana
   *Cooperating partners:* Institute of Physical Biology, Grosuplje; University of Ljubljana ; Slovenian Forestry Institute, Ljubljana; GSF – National Research Center for Environment and Health, Institut for Soil Ecology, Neuherberg, Germany; Community of Celje, Celje; ERICo, Environmental Research & Industrial Co-operation Institute, Velenje; Nova Gorica Polytechnic, Nova Gorica; Limnos – Company for Applied Ecology, d. o. o., Ljubljana
3. **Recycling and Use of Waste**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* University of Maribor; Esotech, d. d., Velenje; National Institute of Biology, Ljubljana; Domžale – Kamnik Wastewater Treatment Plant, d. o. o., Domžale; National Institute of Chemistry, Ljubljana

## Advanced Control Technologies

*Head: Prof. Stanko Strmčnik*

*Project Activity Group:*

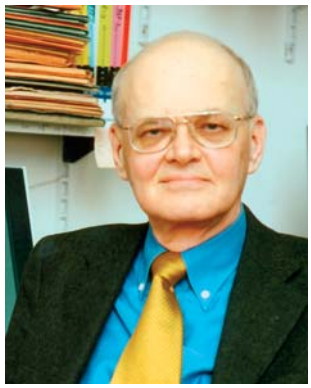
1. **Advanced Control Methods**
   *Leading institution:* University of Ljubljana, Faculty of Electrical Engineering, Ljubljana
   *Cooperating Partners:* Jožef Stefan Institute, Ljubljana; Inea, d. o. o., Ljubljana; Metronik, d. o. o., Ljubljana; Goap Nova Gorica, d. o. o., Solkan; Liko Pris, d. o. o., Vrhnika; Špica International, d. o. o., Ljubljana; Telem, d. o. o., Maribor; Lek, d. d., Ljubljana; Domžale – Kamnik Wastewater Treatment Plant, d. o. o., Domžale
2. **Automatic On-line Supervision of Processes and Product Quality Control**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* University of Ljubljana, Faculty of Electrical Engineering, Ljubljana; Inea, d. o. o., Ljubljana; Domel, d. d., Železniki; Telem, d. o. o., Maribor; FDS Research, d. o. o., Trzin; Špica International, d. o. o., Ljubljana
3. **Technologies of Distant and Distributed Control**
   *Leading institution:* University of Maribor, Faculty of Electrical Engineering and Computer Science, Maribor
   *Cooperating partners:* Jožef Stefan Institute, Ljubljana; University of Ljubljana, Faculty of Electrical Engineering, Ljubljana; Inea, d. o. o., Ljubljana; Špica International, d. o. o., Ljubljana; Telem, d. o. o., Maribor
4. **Decision Support for Control in Production**
   *Leading institution:* Jožef Stefan Institute, Ljubljana
   *Cooperating partners:* University of Ljubljana, Faculty of Electrical Engineering, Ljubljana; University of Maribor, Faculty of Electrical Engineering and Computer Science, Maribor; Inea, d. o. o., Ljubljana; Metronik, d. o. o., Ljubljana; Synatec, d. o. o., Idrija; Špica International, d. o. o., Ljubljana
5. **Product Information Management through Complete Lifecycle**
   *Leading institution:* University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana
   *Cooperating partners:* Domel, d. d., Železniki; Alpina, d. d., Žiri
6. **Project Control in System of Orders**
   *Leading institution:* University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana
   *Cooperating partners*: Eti Elektroelement, d. d., Izlake; Liv Plastika, d. o. o., Postojna

# RESEARCH DEPARTMENTS

# DEPARTMENT OF THEORETICAL PHYSICS F-1

***The research program of the department is focused on the theory of condensed-matter physics, statistical physics, physics of nuclei, particles and fields, as well as biophysics and soft condensed-matter physics. The department also maintains its own high-performance computing facility for which it develops the necessary software. These studies are carried out in close collaboration with several experimental groups at the institute, as well as with local and foreign universities or institutes, and are included in various international projects.***

***The Group for the Theory of Condensed Matter and Statistical Physics has been investigating phase transitions and critical phenomena occurring in networks, ferroelectrics, and on solid surfaces. Another major activity was the study of strongly correlated electron systems, high-temperature superconductors, and quantum coherent electron devices.***



Head:
***Prof. Raša Matija Pirc***

Following the example of inorganic relaxor ferroelectrics, we have developed a spherical random-bond random-field (SRBRF) model of relaxor polymers. These are copolymers of the type P(VDF-TrFE), irradiated by high-energy electrons, and terpolymers such as P(VDF-TrFE-CFE). It has been assumed that irradiation and/or structural disorder break up the ferroelectric lamellar structure in these systems, thus giving rise to a set of polar nano-regions, which interact through infinitely ranged random forces or bonds and are also subject to random electric and elastic fields. A general solution of the SRBRF model has been presented, and the linear and nonlinear dielectric susceptibilities as well as the giant electrostriction constant have been calculated.

We have initiated research of the magnetic properties of complex spin networks as models for self-assembled structures of nanoparticles. These structures appear as prominent examples of new functional materials. We have studied magnetization reversal processes driven by the external field and determined the hysteresis-loop properties and their dependence on the structural parameters. In particular, we have shown that the coercive field increases with the increased topological inhomogeneity of the spin-network, in contrast to classical memory materials and disordered systems.

**Within a model of high-temperature superconductivity appropriate for cuprates, the superconducting transition temperature has been calculated as a function of doping.**

Studying the theory of strongly correlated electrons we have shown that the properties of the t-J model account well for the experiments in cuprates. In particular they describe the universal behaviour for intermediate doping, the emergence of the pseudogap and the resistivity saturation for low doping. An analytical approach to the t-J model, based on the equations of motion, was applied for the calculation of the transition to the superconducting phase, whereby the attractive interaction is mediated by antiferromagnetic fluctuations.

We have studied the influence of topological frustration on spin dynamics in strongly correlated systems and have calculated the dynamical spin structure factor of a two-dimensional model of frustrated spin dimers as a function of wave vector and temperature. We have shown that at low temperatures the peak belonging to the lowest spin excitations is split due to spin anisotropy, in accord with the experimental data on neutron

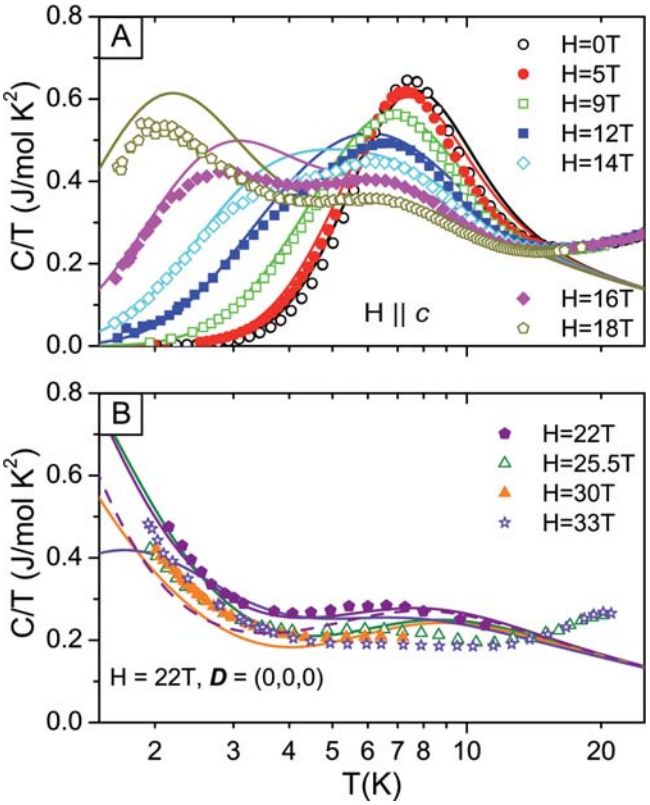



*Figure 1: Comparison of experimental data and numerical calculations of the specific heat of $SrCu_2(BO_3)_2$ as a function of the temperature and external magnetic field. Measurements were performed at the National High Magnetic Field Laboratory in Los Alamos, New Mexico. Numerical calculations based on the microscopic anisotropic frustrated spin model were done in the Group for Theoretical Physics.*
*Article: Jorge, G. A., Stern, R., Jaime, M., Harrison, N., Bonca, Janez, El Shawish, Samir, Batista, C. D., Dabkowska, H. A., Gaulin, B. D. Crystal symmetry and high-magnetic-field specific heat of $SrCu_2(BO_3)_2$. Phys. rev., B, Condens. Mater. Phys., 71 (2005), pp. 092403-1–4.*

scattering experiments in the quasi two-dimensional crystal $SrCu_2(BO_3)_2$. The unusual temperature dependence of the calculated spectra is also in agreement with inelastic neutron scattering measurements.

By applying the density-functional-theory methods we investigated the structural, mechanical, electronic and optical properties of nanomaterials, in particular of molybdenum-based nanowires. Our comparison of the predicted properties with the experimental results contributed significantly to the structure determination of Mo-based nanowires and to a better understanding of their mechanical properties.

***The Theoretical Physics of Nuclei, Particles and Fields group has investigated the structure of hadrons, effective theories of weak and electromagnetic mesonic decays, the unified theory of elementary interactions, the relativistic theory of membranes and carried out precise calculations of the properties of three-body systems in atomic physics.***

In our study of the electroweak amplitudes for pion production in the channels dominated by low-lying nucleon excitations we have finished the research in the delta resonance sector.

Using heavy meson chiral perturbation theory we have found that in the weak decay of the B meson into two Ds and anti-Ds mesons, the nonfactorizable contributions dominate the decay width.

In the B meson decay to two pi mesons we have considered final state interactions coming from the exchange of $\pi$-$\pi$, a1-$\pi$ and $\rho$-$\rho$ states. These contributions are very important in the explanation of the rather large experimental decay width of the $B^0$ decay into two neutral pi mesons.

Using existing theoretical limits for the semileptonic form factors and relying on heavy meson chiral theory, we have included contributions of charm meson resonances into the parameterization of the charm meson form factors for the semileptonic decays of the D meson into light pseudoscalar or vector mesons.

The effect of isospin breaking on the extraction of the CKM unitarity triangle angle alpha from decay channels $B\rightarrow\pi\,\pi$, $\pi\,\rho$, $\rho\,\rho$ has been determined. It has been shown that D-bar D oscillations affect the extraction of the angle gamma of the CKM unitarity triangle from $B\rightarrow D\,K$ decays only at the second order in small parameters.

*Figure 2: Simulated accident trajectory of the Pilatus PC-9 aircraft following the collision with a tree, at Spodnji Žerjavci, 3 March 2004. View towards west-northwest. R. Krivec; technical report for Ministry of Defence.*

We have shown that in the SO(10) grand unified models with split supersymmetry, the masses of right-handed neutrinos can be generated radiatively. Such a model predicts degenerate light neutrinos, a large atmospheric mixing angle and b-tau unification.

By generalizing the quantum field theory to Clifford space we have found a new possible framework for the resolution of the cosmological constant problem. We also studied curved Clifford spaces, and published a review paper on the research of the physics in Clifford space.

Double-ionization problems treated (special cases of the three-body problem in atomic physics) included the analysis of the form of the photoelectron energy distribution. The new quasi-linearization method (QLM) was shown to be superior to the standard WKB method, as it is much more precise, and in addition can be applied everywhere including singular potentials where the perturbation series diverges.

In the framework of a project with the Ministry of Defence, The Laboratory for HPC and aerospace simulations has evaluated the accident of the Pilatus aircraft on 3 March 2004 by constructing an aerodynamic model of the aircraft as well as a simulation of the trajectory of the damaged aircraft.

***The Theoretical Biophysics and Soft Matter Physics group focused on polyelectrolytes, liquid crystals, colloids, and phospholipid and biological membranes***

We have studied the effect of frozen Coulombic charge disorder on interactions between two charged plates. We have shown that nonlinearities in the effective action of the Coulomb fluid give rise to non-vanishing interactions between surfaces even if they are electrically neutral as long as the surface charge distribution is characterized by a finite width. On the level of the Poisson-Boltzmann approximation the frozen charge disorder does not influence the interactions at all, but the disorder effects become important in the limit of strong electrostatic coupling.

**It has been shown that nonvanishing Coulombic interactions can act between two surfaces that are on average electro-neutral, if the surface-charge distribution is characterised by a finite width.**

We have explored the area of the phospholipid vesicle phase diagram where non-axisymmetric shapes are stable. We have analysed the structural hierarchy of hybrid shapes, such as rackets, boomerangs, and starfish, all consisting of an oblate body and at least one prolate arm. Our results have

filled the gap in the parameter space between the oblate and the prolate axisymmetric shapes.

The phase diagram of two dimensional colloids has been studied and lattices other than hexagonal lattice have been found to be stable under certain conditions. Furthermore, the equation of state of three-dimensional colloidal suspensions has been explored. The paradox concerning pressure and effective interactions has been exposed and solved.

We have studied film structures of a smectic C liquid-crystalline phase of dimer molecules. Upon cooling, the free surface of the film starts to fold, forming thick- and thin-film areas interpenetrating each other. Such a labyrinth-like structure of valleys and crests violates the usual rule that a liquid always has the smallest possible surface at a given volume. We have theoretically explained the switching of columnar structures formed by bow-shaped molecules and we have proposed a model of labyrinth structure formation. Such a mechanism should be relevant in all systems where the density of the surface layer is smaller than the bulk value.

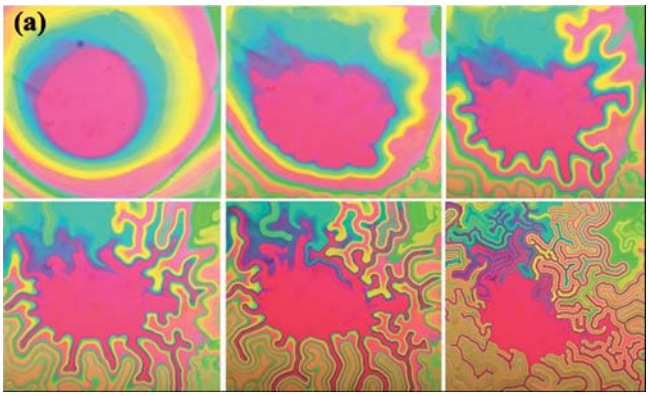



*Figure 3: Free suspended film of material observed in the reflection mode: film region with strong thickness gradient, the central part is thinner than the outer part. Upon lowering the temperature (from 97.6 to 97.1 ° C ), the circular edge dislocation lines develop into the labyrinth structure. Article: D. Pociecha, E. Górecka, N. Vaupotič, M. Čepič, J. Mieczkowski, Spontaneous breaking of minimal surface condition: labyrinths in free standing smectic films. Phys. Rev. Lett., 95 (2005), pp. 207801-1–4*

We investigated calcium dynamics within the context of intracellular communication in airway smooth-muscle cells. The basic research was devoted to mutual interactions between myosin light chain kinase, calmodulin and calcium. We found that, in particular, this complex molecular system has an important role in the time-delay of the calcium signal in the process of force development. Furthermore, we investigated the interrelation between the phosphorylation of myosin and the development of force.

## Some outstanding publications in the year 2005


1. B. Tadić, K. Malarz, K. Kułakowski, Magnetisation reversal in spin with complex geometry. Phys. Rev. Lett., vol. 94 (2005), pp. 137204-1–4
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6. A. Naji, R. Podgornik, Quenched charge disorder and Coulomb interactions. Phys. Rev., E Stat. Phys. Plasmas Fluids Relat., 72 (2005), pp. 041402-1–11


## Awards and appointments

1. Dr. Jure Zupan: The Jožef Stefan Golden Emblem Prize, Chiral corrections in electroweak processes with heavy mesons
2. Kanduč Matej: Students Prešeren Award, University of Ljubljana, Faculty of Mathematics and Physics, Dynamical Two-particle Phenomena in Nanostructures

## Organization of conferences, congresses and meetings

1. Exciting hadrons, Bled, Slovenia, 11. 7. – 18. 7. 2005

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# TEXTBOOKS AND LECTURE NOTES

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2. Primož Ziherl, Gregor Skačej: Rešene naloge iz termodinamike: (Zbirka izbranih poglavij iz fizike, 42), Ljubljana, DMFA - založništvo, 2005.
3. Janez Ferbar, Ana Gostinčar-Blagotinšek, Danica Mati, Nada Razpet, Mojca Čepič: Naravoslovje - fizika: (Zbirka Študijska gradiva, zv. 14), 2. dopolnjena izd., Koper, Pedagoška fakulteta, = Capodistria, Facolta di studi educativi, = Koper, Faculty of Education, 2005.
4. Nataša Vaupotič: Laboratorijske vaje iz vsebinskih sklopov Barve ter Svetloba in slike: študijski program izpopolnjevanja za poučevanje naravoslovja v 6. in 7. razredu osnovne šole: Maribor, Pedagoška fakulteta, Oddelek za fiziko, 2005.

# THESES

## B. Sc. Theses

1. Kanduč Matej: Dynamical Two-particle Phenomena in Nanostructures (Prof. Janez Bonča)
2. Kokalj Jure: Resonant Raman scattering at the Xe $L_3$-edge (Dr. Matjaž Žitnik)
3. Košnik Nejc: Decay $B \to \pi\pi K^+$ as the signal of new physics (Prof. Svjetlana Fajfer)

# INTERNATIONAL PROJECTS

1. Fundamentals of Nanoelectronics
   RTNNANO; 6. FP; MRTN-CT-2003-504574
   EC; Lancaster University, Lancaster, Great Britain
   Prof. Anton Ramšak
2. Unifying Principles in Non-equilibrium Pattern Formation
   PATTERNS; 6. FP; MRTN-CT-2004-005728
   EC; The University of Nottingham, University Park, Great Britain
   Prof. Bosiljka Tadič
3. New Polaronic States and their Role in Giant Piezoelectric Effect Formation
   NATO; PST.EAP.CLG 980378
   Prof. Siegmar Kapphan, Universität Osnabrück, Osnabrück, Germany
   Prof. Valentin Vikhnin, Russian Academy of Sciences, St. Petersburg, Russia
   Prof. Raša Pirc
4. Emergent Behaviour in Correlated Matter
   COST P16; EC
   Prof. Peter Prelovšek
5. Physics of Risk
   COST P10; EC
   Prof. Bosiljka Tadić
6. Diffusion Processes on Structured Networks
   SI-AT/04-05/001
   Prof. Stefan Thurner, Univ. Klinik HNO, AKH Wien, Vienna, Austria
   Prof. Bosiljka Tadić
7. Chiral Correction and Physics of Heavy Quarks
   PROTEUS
   Dr. Damir Bećirević, Laboratorie de Physique Theorique, Universite Paris Sud, Centre d'Orsay, Orsay-Cedex, France
   Prof. Svetlana Fajfer
8. Physics of heavy hadrons within and beyond Standard Model
   BI-HR/05-06-011
   Dr. Guberina Branko, Institut "Ruđer Bošković", Zagreb, Croatia
   Prof. Svetlana Fajfer
9. Complex Molecules as Dopants
   SLO-JPN
   Prof. Hideo Takezoe, Tokyo Institute of Technology, Department of Organic and Polymeric Materials, Tokio, Japan
   Prof. Čepič Mojca
10. Structure of Phases Formed by Complex Molecules
    BI-PL/04-05-012
    Prof. Gorecka Ewa, Warsaw University, Department for Chemistry, Warsaw, Poland
    Prof. Mojca Čepič

11. Meson Degrees of Freedom on Light Baryons
    BI-PT-04-06-015
    Prof. Manuel Fiolhais, Departamento de Fisica, Universidade de Coimbra, Coimbra, Portugal
    Prof. Bojan Golli, Asst. Prof. Simon Širca
12. Simulation and Analysis of Complex Networks in Planetary Dynamics
    BI-SCG/05-06-020
    Dr. Aleksandar Bogojević, Institut za fiziku, Beograd-Zemun, Serbia and Montenegro
    Prof. Bosiljka Tadić
13. Models of Correlated Electrons and Frustrated Spin Systems
    BI-US/04-05/27
    Dr. James Gubernatis, Los Alamos National Laboratory, Los Alamos, NM, USA
    Prof. Janez Bonča

# R & D GRANTS AND CONTRACTS

1. Study of one-and two-dimensional antiferromagnets with a spin gap
   Prof. Janez Bonča
2. High performance computing algorithms in theoretical physics
   Dr. Rajmund Krivec
3. Quantum many-body dynamics in nanostructures and quantum information
   Dr. Kristjan Haule
4. Strongly correlated electron systems close to the Mott transition
   Prof. Raša Matija Pirc, Dr. Kristjan Haule

# RESEARCH PROGRAMS

1. Theoretical physics of nuclei, particles and fields
   Prof. Svjetlana Fajfer
2. Theory of condensed matter and statistical physics
   Prof. Janez Bonča
3. Biophysics of polymers, membranes, gels, colloids and cells
   Prof. Rudolf Podgornik

# VISITORS FROM ABROAD

1. Prof. Milan Damnjanović, University of Belgrade, Belgrade, Serbia and Monte Negro 4.–5. 1. 2005
2. Prof. Stefan Thurner, University of Vienna, Vienna, Austria, 16. 1.–21. 1., 4.–6. 7. and 11.–14. 12. 2005
3. Dr. Jadwiga Szydlowska, Department of Chemistry, Warsaw University, Warsaw, Poland, 17.–30. 1. 2005
4. Prof. Silvia Tomić, Institut for Physics, University of Zagreb, Zagreb, Croatia, 1. 4. 2005
5. Dr. Tomislav Vuletić, Institut for Physics, University of Zagreb, Zagreb, Croatia, 1. 4. 2005
6. Dr. Michal Malinsky, SISSA, Trieste, Italy, 24. 2. 2005
7. Prof. Damir Bećirević, Laboratoire de Physique Théorique, Université Paris Sud, Centre d'Orsay, Orsay, France, 8.–18. 5. 2005 and 30. 9.–5. 10. 2005
8. Prof. Alberto Diaz Guilera, University of Barcelona, Barcelona, Spain, 24.–26. 5. 2005
9. Wong Ten It, Sains University, Penang, Malaysia, 26. 5.–27. 6. 2005
10. Jelena Živković, University of Vienna, Vienna, Austria, 1.–29. 6. 2005 and 5.–16. 12. 2005
11. Prof. Manuel Fiolhais, University of Coimbra, Coimbra, Portugal, 9.–18. 6. and 21.–31. 8. 2005
12. Prof. Sushanta Dattagupta, S. N. Bose National Centre for Basic Science, Calcutta, India, 10.–24. 6. 2005
13. Prof. Hiroshi Hasegawa, University of Tokyo, Tokyo, Japan, 29. 6. 2005
14. Prof. Veljko Dmitrašinović, Institut Vinča, Belgrade, Serbia and Montenegro, 6.–11. 7. and 5.–14. 12. 2005
15. Prof. Milutin Blagojević, Institut for Physics, Belgrade, Serbia and Montenegro, 12. 7. 2005
16. Milovan Šuvakov, Institut for Physics, Belgrade, Serbia and Montenegro 15. 7. – 31. 12. 2005
17. Prof. Wojciech Broniowski, Institute for Nuclear Physics, Krakow, Poland, 29. 8.–4. 9. 2005
18. Prof. William Pezzaglia, Physics Department, University of Santa Clara, Santa Clara, USA, 7.–10. 9. 2005
19. Dr. Roberts Eglitis, University of Osnabrück, Osnabrück, Germany, 14.–21. 9. 2005
20. Dr. Tomasz Durakiewicz, Los Alamos National Laboratory, Los Alamos, USA, 14. 9. 2005
21. 21. Prof. David Corcoran, Physics Department, University of Limerick, Limerick, Ireland, 13.–15. 9. 2005
22. Prof. Siegmar Kapphan, Physics Department, University of Osnabrück, Osnabrück, Germany, 4.–11. 10. 2005
23. George Giavaras, University of Lancaster, Lancaster, Great Britain, 5. 10.–31. 21. 2005
24. Prof. Holger Fehske, Institut for Physics, Ernst-Moritz-Arndt University of Greifswald, Greifswald, Austria, 6. 10. 2005
25. Prof. Ulrich Nierste, Institut für Theoretische Teilchenphysik, University of Karlsruhe, Karlsruhe, Germany, 19.–22. 11. 2005
26. Prof. Valentin Vikhnin, A. F. Ioffe Physical Technical Institute, St. Petersburg, Russia, 2.–30. 11. 2005
27. Prof. Philip Moriarty, Physics and Astronomy School, University of Nottingham, Nottingham, Great Britain, 20.–22. 11. 2005
28. Prof. Adolfo Avella, University of Salerno, Salerno, Italy, 20.–26. 11. 2005
29. Dr. Blaženka Melić, Institute Rudjer Bošković, Zagreb, Croatia, 18.–19. 12. 2005
30. Dr. Piero Nicolini, Polytechnic of Turin, INFN, Turin, Italy, 1.–31. 12. 2005

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23. Dr. Kristjan Haule
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27. Dr. Darko Veberič*
28. Dr. Jure Zupan

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31. Matej Kanduč, B. Sc.
32. Jure Kokalj, B. Sc.
33. Nejc Košnik, B. Sc.
34. Jernej Mravlje, B. Sc.
35. Miha Nemevšek, B. Sc.
36. Mihael-Matjaž Zemljič, B. Sc.

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*** Member of industrial or other organisation

# DEPARTMENT OF LOW AND MEDIUM ENERGY PHYSICS F-2

***The F-2 department conducts basic and applied research in low and medium energy physics. Low energy physics accounts for our atomic physics research, while the area of nuclear physics studied at the department can be classified as intermediate energy physics. The third research field of the department is radiological environmental protection and concerns monitoring nuclear objects and environmental radioactivity. The department also operates the Ecological Laboratory with a Mobile Unit as a specialised Civil Protection unit.***

Head:
***Dr. Matej Lipoglavšek***

Fundamental research in nuclear physics is performed by the Structure of Hadronic Systems Group [1]. In the framework of the A1 Collaboration at the Nuclear Physics Institute (University of Mainz), work on two groups of measurements has been continued. In the Virtual Compton Scattering experiment (VCS) we are trying to determine the single-spin asymmetries (where only the electron beam is polarised) as well as the double-spin observables (where the recoil polarisation is also measured). The main goal of the VCS experiments is to determine several linear combinations of generalized polarisabilities of the nucleon at intermediate momentum transfers (around 0.33 $GeV^2$). In conjunction with the experiments performed at low $Q^2$ at the MIT-Bates laboratory, and at high $Q^2$ at the Jefferson Lab, we are attempting to determine the $Q^2$-dependence of the polarisabilities [2]. We have also participated in the preparation of prototype silicon detectors for the triple coincidence experiment $^{12}C$(e, e pi- p), in which delta resonance excitation in the nuclear environment is studied.

At the Jefferson Lab we have performed the E01-015 experiment (SRC, short-range correlations), in which scattered electrons as well as the ejected protons and neutrons from deuteron and carbon targets are detected in triple coincidence. For the first time in Hall A, the BigBite large-acceptance spectrometer has been used. The ultimate goal of the experiment is an improvement of our understanding of nucleon-nucleon short-range correlations in nuclei. We have also performed measurements for the HAPPEX II and HAPPEX-He experiments (E99-115 and E00-114) with hydrogen and helium targets, respectively. The purpose of the HAPPEX group of experiments is an accurate determination of the strange-quark contributions to the charge and anomalous magnetic moment of the nucleon. To this end, very small parity-violating asymmetries (on the order of $10^{-6}$) induced by the electromagnetic-weak interference processes need to be measured. We also helped prepare the trigger electronics for the E02-013 experiment, dedicated to the measurement of the neutron electric form-factor at high momentum transfers. Production runs for this experiment are anticipated in spring 2006.

In collaboration with the Institute of Physics of the Slovak Academy of Science we continued work on the development of a new approach to the description of the radiative capture of nucleons with the direct-semidirect (DSD) model and initiated a study of the extension of its applicability to all direct nuclear reactions.

As part of the ongoing study of the use of high-purity germanium detectors in environmental monitoring programs, we developed a computer code for the calculation of the efficiencies of extended samples based on point-source calibration of the spectrometer (efficiency transfer) [3], which, when compared to traditional calibration methods, results in a simplified procedure, shorter calibration time and lower overall costs. We also commenced the development of an entirely new approach to the analysis of gamma-ray spectra, based on a search for the optimal combination of computed spectra belonging to the individual radionuclides from a context-sensitive nuclide library that matches the measured spectrum best. The required activities of the radionuclides actually present in the sample are simply obtained as the coefficients of the optimal linear combination. In this way, our approach reduces to a single step the many separate phases of the traditional analysis procedure, i.e., the energy and peak-width calibration phase, the peak location and peak-area-determination phase, the identification of the radionuclides in the sample, the subtraction of the background counts, the application of the interference correction algorithm and the final calculation of the activities. We also developed an optimization method for the determination of the counting times for batch processing of samples containing short-lived radionuclides.

Research in low energy physics is carried out mainly in the framework of the research program “Studies of atoms, molecules and structures with photons and particles”. Below we list the main research activities and field achievements in 2005:

– Photoabsorption: structural studies of nanomaterials (MoSI nanotubes, nanostructured iron oxides, microporous catalysts and thin PZT films), of catalytic micro and mesoporous aluminophosphates and silicates with built-in cations; $KNbO_3$ ceramics, prepared by mechanochemical synthesis; amorphous precursors $Pb(Zr,Ti)O_3$ for sol-

gel synthesis; iron oxides treated by hydrogen plasma; Cu, Ni, Co, Mn, Fe complexes in organic molecules and thin $CuO/CeO_2$ layers. Structural changes in ferroelectric $SrTiO_3$ crystal were investigated with isotopic substitution, in Pb polluted soil samples from Mežica, in Cu-humatic complexes of vineyard soils, in cellulose complexes, in Fe from ink writings in historical manuscripts (microfocused beam of SRS Daresbury). Pilot atomic absorption measurements were performed in the caesium and iodine L edge energy regions in two new types of high temperature absorption cells: one with welded beryllium windows and in a sulfratron plasma cell.

- High resolution X-ray spectroscopy: determination of absolute cross section for twofold ionisation of 1s shell of Si for protons in the energy range 1 - 3 MeV, determination of the relative hypersatellite yield in Mg and Al using the ID21 beamline at ESRF in Grenoble with the collaboration of the Physics Department of University of Fribourg, resonant Raman X-ray spectroscopy around the Xe L3 edge with the first characterization of discrete states converging to the threshold.
- Fluorescence, ionic and electronic spectroscopy [4, 5]: publishing of a series of fluorescence spectral data recorded in the visible energy range after the fluorescence decay of doubly excited states of He below the N=2 threshold, measurements of the VUV photons emitted by these same states in the homogeneous electric field perpendicular and parallel to the polarisation of the incoming light. Measurements of half-life changes under the influence of a variable magnitude electric field.
- Surface studies: multichannel energy detection with the angular resolving electron analyser of HASPES experimental station at beamline ALOISA (Elettra), measurements of structure, orientation and long-range-order of electronic states formed on in-situ ultra thin organic films of technologically promising materials such as: cooper ftalocyanin ($CuC_{32}N_8H_{16}$, CuPc), oligotyofen (O-T6), pentacen ($C_{22}H_{14}$), dianhydride perylene acid ($C_{24}H_8O_6$, PTCDA) and others, which are loaded in the ultra-high-vacuum environment on ordered inorganic substrates such as Au, Ag, and Ge. Studies of additional thin layers TiO2 on Ti/TiN layers and their effect on the corrosion properties, study of thin layers of TiCrN and CrN.
- Precise determination of iron concentration in samples: preparation and characterization of porous $LiFePO_4$ which is a promising material for the production of cathodes in batteries, study of ink interaction with paper determining the surface and bulk Fe concentration.
- Studies of vibrationally excited hydrogen molecules and their interaction with surfaces: development of a spectrometer for the detection of vibrationally excited molecules using the effect of dissociative attachment, design/production of a plug-in for simultaneous determination of the hydrogen depth profile with IBA method ERDA, initiation of systematic studies of hydrogen recombination on surfaces.
- Ion (micro)beam research: measurement of deposition on plasma limiters and determination of the fusion fuel (deuterium) deposited in the pump channels of the fusion reactor TEXTOR, (Juelich, Germany). Determination of elemental maps of physiological and toxic elements of the plant Thlaspi praecox Wulfen, - hyperaccumulator of toxic Cd and Zn, with ion micro-beam. Identification of BaSO4 and polyacetal wear particles in the periprosthetic tissue around loosened isoelastic hip stems by nuclear micro-probe in collaboration with the Orthopaedic Clinic in Ljubljana. Development of systems for current normalisation of RBS/ERDA and PIXE measurements with an external ion beam.

## Some outstanding publications in the year 2005


1. J. J. Kelly et al. (Jefferson Lab Hall A Collaboration), Recoil polarization for Delta excitation in pion electroproduction, Phys. Rev. Lett. 95 (2005) 102001
2. D. J. Hamilton et al. (Jefferson Lab Hall A Collaboration), Polarization transfer in proton Compton scattering at high momentum transfer, Phys. Rev. Lett. 94 (2005) 242001
3. T. Vidmar, EFFTRAN - A Monte-Carlo efficiency transfer code for gamma-ray spectrometry, Nucl. Inst. Meth. A 550 (2005) 603
4. Harries JR et al., Partial photoionization of helium into the 2s2 2S and 2p2 2P ion states in the 3lnl' doubly-excited region, J. Phys. B, L153, (2005)
5. Coreno et al., Branching ratios in the radiative decay of helium doubly excited states, Phys. Rev. A72, 052512, (2005)

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## ORIGINAL ARTICLES


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2. Iztok Arčon, Johannes Teun van Elteren, Hylke J. Glass, Alojz Kodre, Zdenka Šlejkovec: EXAFS and XANES study of arsenic in contaminated soil. X-ray spectrom., Vol. 34, pp. 435-428, 2005.
3. Iztok Arčon, Miran Mozetič, Alojz Kodre: XAS study of oxygen plasma-treated micronized iron oxide pigments. Vacuum, 80, pp. 178-183, 2005.
4. N. P. Barradas, Primož Pelicon, (25 authors): A round robin characterisation of the thickness and composition of thin lutra-thin AlNO films. Nucl. instrum. methods phys. res., B Beam interact. mater. atoms, Vol. 227, pp. 397-419, 2005.
5. M. Coreno, K. C. Prince, R. Richter, M. de Simone, Klemen Bučar, Matjaž Žitnik: Brancing rations in the radiative decay of helium doubly excited states. Phys. rev., A, Vol. 72, pp. 052512-1-052512-8, 2005.
6. M. Coreno, Matjaž Žitnik, (7 authors): A new system for photon induced fluorescence spectroscopy applied to the study of doubly excited states in helium. J. electron spectrosc. relat. phenom., Vol. 144-147, pp. 39-42, 2005.
7. Dean Cvetko, F. Ratto, A. Cossaro, Gregor Bavdek, A. Morgante, L. Floreano: Displacive phase transition at the 5/3 monolayer of Pb on Ge(001). Phys. rev., B, Condens. matter mater. phys., Vol. 72, pp. 045404-1-045404-9, 2005.
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10. Miran Gaberšček, Robert Dominko, Marjan Bele, Maja Remškar, Darko Hanžel, Janko Jamnik: Porous, carbon-decorated $LiFePO_4$ prepared by sol-gel method based on citric acid. Solid state ion., Vol. 176, no. 19/22, pp. 1801-1805, 2005.
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32. Žiga Šmit, Janka Istenič, Viktor Gerdun, Zoran Milić, Ana Mladenovič: Archaeometric analysis of Alesia group brooches from sites in Slovenia. Arheol. vestn., Letn. 56, pp. 213-233, 2005.
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34. Žiga Šmit, Primož Pelicon, Jurij Simčič, Janka Istenič: Metal analysis with PIXE: the case Roman military equipment. Nucl. instrum. methods phys. res., B Beam interact. mater. atoms, Vol. 239, pp. 27-34, 2005.
35. Janez Štupar, Franci Dolinšek, Jurij Simčič, Mirko Bizjak, Bojan Budič: Trace element analysis of the hair of Duke Mirko Petrovic-Njegos - a possible means of clarification of his death. Trace elem. electrolytes, Vol. 22, no. 2, pp. 118-126, 2005.
36. Tim Vidmar: EFFTRAN - A Monte Carlo efficiency transfer code for gamma-ray spectrometry. Nucl. instrum, methods phys res., Sect. A, Accel., Vol. 550, pp. 603-608, 2005.
37. Tim Vidmar, Andrej Likar: Calculation of total efficiencies of extented samples for HPGe detectors. Nucl. instrum, methods phys res., Sect. A, Accel., Vol. 555, pp. 251-254, 2005.
38. Jedert Vodopivec, Miloš Budnar, Primož Pelicon: Application of the PIXE method to organic objects. Nucl. instrum. methods phys. res., B Beam interact. mater. atoms, Vol. 239, pp. 85-93, 2005.
39. Y. Zhang, W. J. Weber, Alenka Razpet, Göran Possnert: Electronic stopping powers for He, Be and F ions in Au. Nucl. instrum. methods phys. res., B Beam interact. mater. atoms, Vol. 227, pp. 479-484, 2005.
40. Matjaž Žitnik, Marko Jakomin, Primož Pelicon, Zdravko Rupnik, Jurij Simčič, Miloš Budnar, Nataša Grlj, M. Marzi: Port of Koper - elemental concentrations in aerosols by PIXE. X-ray spectrom., Vol. 34, pp. 330-334, 2005.
41. Žiga Šmit: Analiza fragmenata tkanina metodom PIXE. Diana (Beogr.), no. 10, pp. 147-148, 2004/2005.
42. Iztok Čadež: Ioni v zraku. Življ. teh., Leto 56, No. 3, pp. 45-50, 2005.
43. Peter Kump: Rentgenska fluorescenca. Kem. šoli, Let. 17, No. 4, pp. 9-16, 2005.


## REVIEW ARTICLES AND CHAPTERS IN BOOKS


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2. Mateja Kos, Žiga Šmit: Glassmaking in the venetian manner. X-ray for archaeology, M. Uda, ed., Guy Demortier, ed., I. Nakai, ed., Dordrecht, Springer, 2005, pp. 159-162.


## PUBLISHED CONFERENCE PAPERS

### Regular Papers


1. Iztok Arčon, Alojz Kodre, Jana Padežnik Gomilšek, Marjan Hribar, Andrej Mihelič: Cs L-edge EXAFS atomic absorption background. Phys. scr., T, Vol. 115, 2005, pp. 235-236.
2. Iztok Arčon, Barbara Malič, Alojz Kodre, Marija Kosec: Zr K-edge EXAFS study of PZT thin film formation from sols: presented at 12th X-ray Absorption Fine Structure International Conference (XAFS12) Malmo/Lund, Sweden June 22-27, 2003. Phys. scr., T, Vol. 115, pp. 448-449, 2005.
3. R. A. Bark, Matej Lipoglavšek, S. M. Maliage, S. S. Ntshangase, A. Shevchenko: Aspects of nuclear physics research at iThemba LABS, South Africa: presented at NUSTAR 2005, International Conference on the interface between NUclear STructure, Astrophysics and Reactions, Guildford, UK, 5-8 January 2005. J. phys., G Nucl. part. phys., Vol. 31, pp. S1747-S1752, 2005.
4. Marjan Bele, Robert Dominko, Miran Gaberšček, Maja Remškar, Darko Hanžel, Iztok Arčon, Janko Jamnik: Mechanism of porous olivine-carbon composite formation from citrate-based gels: [lecture]. Proceedings, 7th Multinational Congress on Microscopy,

June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, "Jožef Stefan" Institute, 2005, pp. 301-302.

5. Hall A Collaboration: Jian-Ping Chen, Simon Širca, (48 authors): Neutron spin structure measurements in JLAB Hall A. Structure of the nucleon at large Bjorken x: 2nd International Workshop on the Structure of the Nucleon at Large Bjorken x, HiX2004, Marseille, France, 26-28 July 2004(AIP conference proceedings, 747), Claude Bourrely, ed., Zein-Eddine Meziani, ed., Jacques Soffer, ed., Melville, American Institute of Physics, 2005, pp. 83-87.
6. Iztok Čadež, Zdravko Rupnik, Sabina Markelj: Cross section for dissociative electron attachment to $H_2$ and $D_2$. Proceedings, XXVII ICPIG 2005, International Conference on Phenomena in Ionised Gases, Eindhoven, July 17-22, 2005, The Netherlands, Eindhoven, Faculty of Applied Physics, 2005, 4 pp.
7. Urška Doberšek, Terezija Golob, Mojca Jamnik, Jasna Bertoncelj, Peter Kump, Marijan Nečemer: Content of elements in honey from different Slovenian regions. Proceedings of the 2nd Central European Meeting & 5th Croatian Congress of Food Technologists, Biotechnologists and Nutritionists: [17th-20th October 2004, Opatija, Croatia], Damir Karlović, ed., Zagreb, Food Technologists, Biotechnologists and Nutritionists Society, 2005, pp. 281-286.
8. Bojan Golli, Simon Širca: Chiral models for exciting baryons: presented at Mini-Workshop "Exciting Hadrons", July 11-18,2005, Bled, Slovenia. Blejsk. delavn. fiz., Vol. 6, pp. 56-63, 2005.
9. Željka Knežević, Katarina Krpan, Maria Ranogajec-Komor, Saveta Miljanić, Branko Vekić, Zdravko Rupnik: Povezivanje termoluminiscentnog čitača s računalom te razvoj programa za obradu mjernih podataka. Zbornik radova VI. simpozija Hrvatskog društva za zaštitu od zračenja s međunarodnim sudjelovanjem, Stubiške Toplice, Hrvatska, 18.-20. travnja 2005, Verica Garaj Vrhovac, ed., Nevenka Kopjar, ed., Saveta Miljanić, ed., Zagreb, HDZZ-CRPA, 2005, pp. 111-116.
10. Alojz Kodre, Iztok Arčon, Jana Padežnik Gomilšek, Andrej Mihelič: Atomic absorption background in EXAFS of Rb and Cs in inter-alkaline alloys. Phys. scr., T, Vol. 115, pp. 218-220, 2005.
11. F. S. Komati, Matej Lipoglavšek, (20 authors): Commissioning of the DIAMANT "Chessboard" light charged-particle CsI detector array with AFRODITE. Exotic nuclear systems: International Symposium on Exotic Nuclear Systems(AIP conference proceedings, Nuclear and high energy physics, 802), Melville, American Institute of Physics, 2005, pp. 215-218.
12. Matjaž Korun: Sampling techniques, sample preparation and analaysis of soil samples currently used in Slovenia. Harmonisation of sampling and measurement techniques for the control of radioactivity contaminated soils: workshop: 8.-10. December 2004, Karlsruhe, Germany, [Brussels], European Commision, Directorate General, Joint Research Centre, 2005, 4 pp.
13. Matjaž Korun: Self-reliance and sustainability of nuclear analytical laboratories in small states of Central Europe: the Slovenian case. Technical meeting on Commercial applications of nuclear analytical techniques: meeting report: Vienna, Austria, 23-26 November 2004, Vienna, International Atomic Energy Agency, 2004, pp. 48-51.
14. Jasmina Kožar Logar, Alenka Malej, Mladen Franko: On-line monitoring of diatom lysis by thermal lens spectrometry. 13th ICPPP: International Conference on Photoacustic and Photothermal Phenomena, Rio de Janeiro, Brazil, 05-08 July 2004(Journal de Physique IV, Vol. 125), Helion Vargas, ed., Les Ulis, EDP Sciences, [2004], Vol. 125, pp. 705-707, 2005.
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17. Jana Padežnik Gomilšek, Urška Lavrenčič Štangar, Angela Šurca Vuk, Gvido Bratina, Iztok Arčon, Alojz Kodre: EXAFS study of $SnO_2$ xerogel doped with Sb and PTCDA. Phys. scr., T, Vol. T 115, no. 4, pp. 329-331, 2005.
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23. Matjaž Štuhec, Saveta Miljanić, Branko Vekić: Harmonisation of measurements in radiation protection. Zbornik radova VI. simpozija Hrvatskog društva za zaštitu od zračenja s međunarodnim sudjelovanjem, Stubiške Toplice, Hrvatska, 18.-20. travnja 2005, Verica Garaj Vrhovac, ed., Nevenka Kopjar, ed., Saveta Miljanić, ed., Zagreb, HDZZ-CRPA, 2005, pp. 87-90.
24. M. K. Van Bael, Iztok Arčon, K. Van Werde, D. Nelis, J. Mullens, L. C. Van Poucke: Structure determination by EXAFS of Nb-peroxo-citrato complexes in aqueous solution-gel systems: presented at 12th X-ray Absorption Fine Structure International Conference (XAFS12) Malmo/Lund, Sweden June 22-27, 2003. Phys. scr., T, Vol. 115, pp. 415-417, 2005.
25. Jefferson Lab Hall A and E97103: Xiaochao Zheng, Simon Širca, (45 authors): Precision measurements of the neutron spin structure at Jefferson Lab Hall A. GDH 2004: proceedings of the Third International Symposium on the Gerasimov-Drell-Hearn Sum Rule and Its Extensions, Old Dominion University, Virginia, USA 2-5 June 2004, Sebastian Kuhn, ed., Jian-ping Chen, ed., New Jersey... [etc.], World Scientific, cop. 2005, pp. 73-83.
26. Benjamin Zorko, David Jezeršek, Matjaž Štuhec, Sandi Gobec: Energy dependance of TL dosemeters using $CaF_2$: Mn pellets. Zbornik radova VI. simpozija Hrvatskog društva za zaštitu od zračenja s međunarodnim sudjelovanjem, Stubiške Toplice, Hrvatska, 18.-20. travnja 2005, Verica Garaj Vrhovac, ed., Nevenka Kopjar, ed., Saveta Miljanić, ed., Zagreb, HDZZ-CRPA, 2005, pp. 97-104.
27. Mateja Kos, Tamara Trček Pečak, Žiga Šmit: Raziskovalno delo v muzejih - naravoslovne metode. Zborovanje Slovenskega muzejskega društva, Portorož, 20.-22. 10. 2005, Darko Knez, ed., Ljubljana, Slovensko muzejsko društvo, 2005, pp. 19-23.
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29. Zdravko Rupnik, Primož Pelicon, Jurij Simčič: Krmiljenje mikrožarka ionskega pospeševalnika pri izdelavi mikromehanskih struktur. Uporabniški članki, NIDan 2005, Strokovna konferenca o virtualni instrumentaciji NI DAN 2005, Portorož, 10.2-11.2.2005, National Instruments Slovenija, 2005, 4 pp.
30. Jurij Simčič, Primož Pelicon, Miloš Budnar, Žiga Šmit, Katarina Vogel, Paula Pongrac, Marjana Regvar: Kvantitativne elementne analize bioloških vzorcev s protonskim mikrožarkom. Zbornik prispevkov, Letna delavnica Katedra za fiziologijo rastlin, Marjana Regvar, ed., Ljubljana, Republika Slovenija, Ministrstvo za šolstvo, znanost in šport, 2005, pp. 8-12.

## TEXTBOOKS AND LECTURE NOTES

1. Andrej Likar, Dean Cvetko, Gorazd Planinšič: Zgledi iz fizikalnih merjenj: (Zbirka izbranih poglavij iz fizike, 43), Ljubljana, DMFA - založništvo, 2005.

## THESIS

### Ph. D. Thesis

1. Jure Simčič: 3D proton beam micromachining in SU8 (P. Pelicon, A. Likar)

### B. Sc. Theses

1. Matevž Bevec: Measurements of Backscattering on Materials and Comparisons with Monte-Carlo Calculations (co-mentor M. Korun)
2. Jaka Kovač: Detection of stress corrosion cracking using measurements of electrochemical noise and acoustic emission (Ž. Šmit)
3. Igor Kržič: Calibration of X-ray radiation for applications in the dosimetry (co-mentor M. Štuhec, Ž. Šmit)
4. Agata Müllner: Fe valence state analysis with XANES (I. Arčon)
5. Ksenija Maver: Systematic errors in structural analysis with x-ray absorption method EXAFS (I. Arčon)
6. Primož Vavpetič: Examination of corrosion processes in concrete steels using electrochemical impedance spectroscopy (Ž. Šmit)

## PATENT APPLICATION

1. Zdravko Rupnik, Drago Brodnik, Matej Lipoglavšek
   Flow detection in metallic capillaries, device and detection procedure
   Patent application no. P-200500340

# INTERNATIONAL PROJECTS

1. P5 - Application of Ion Beam Analytical Methods to the Studies of Plasma Wall Interaction in Tokamaks
   EURATOM – MHST
   6. FP, Fusion Association, EURATOM; FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministrstvo za visoko šolstvo, znanost in tehnologijo, Ljubljana, Slovenia
   Asst. Prof. Primož Pelicon
2. P2 - Interaction of Vibrationally Excited Hydrogen with Fusion Relevant Materials
   EURATOM – MHST
   6.FP, Fusion Association, EURATOM; FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministrstvo za visoko šolstvo, znanost in tehnologijo, Ljubljana, Slovenia
   Dr. Iztok Čadež, Prof. Milan Čerček
3. Interaction of Vibrationally Excited Hydrogen with Fusion Relevant Materials
   VEVOF
   6. FP, EURATOM; FU06-CT-2003-00010
   EC; Dr. D. Bartlett, European Commission, DG Research, Brussels, Belgium
   Dr. Iztok Čadež, Prof. Milan Čerček
4. Stabilisation of Iron Gall Ink Containing Paper
   INKCOR
   5. FP; EVK4-CT-2001-00049
   EC; National and University Library, Ljubljana, Slovenia
   Prof. Miloš Gregor Budnar
5. Non-destructive Analysis and Testing of Museum Objects
   COST-G8
   EC; ESF, Prof. Mieke Adriaens, University of Gent, Belgium
   Prof. Žiga Šmit
6. Training of Mr. Marion Leonard Manga
   URT/03001; IAEA Fellow
   IAEA, Vienna, Austria
   Dr. Benjamin Zorko
7. Training of Mr. Elmaddin Guliyev
   IAEA Fellow, AZB/05012
   IAEA, Vienna, Austria
   Dr. Benjamin Zorko
8. Nuclear Microprobe Analysis of Individual Microparticles Found Inside Fusion Reactors, Tissues, Paints and Environment; Development of Nuclear Microprobe Techniques for the Quantitative Analysis of Individual Microparticles
   13264/RBF, RO
   IAEA, Vienna, Austria
   Asst. Prof. Primož Pelicon
9. Technical Cooperation Project RER/1/006: Nuclear Techniques for the Protection of Cultural Heritage Artefacts in the Mediterranean Region
   IAEA, Vienna, Austria
   Prof. Žiga Šmit
10. Development of Post-emergency Impact Assessment Capability
    IAEA
    Dr. Alain Cardoso, IAEA, Vienna, Austria
    Dr. Matjaž Aleš Korun
11. Study of many particle atomic relaxations with magnetic bottle
    PROTEUS
    Prof. Francis Penent, Lab. de chimie physique matiere et rayonnement, CNRS, Unite UMR, Numero 7614, Specialite SC, Paris, France
    Asst. Prof. Matjaž Žitnik
12. Heavy Metal Analysis in Drinking Water and Vines
    BI-GR/02-05-016
    Dr. Nikos Kallithrakas-Kontos, Technical University of Crete, Dept. of Sciences, Laboratory of Analytical and Environmental Chemistry, Chania, Crete, Greece
    Dr. Peter Kump
13. Application of a Novel Method for In-situ Determination of Radiocesium Depth Distribution in Soil
    BI-GR/04-06-003
    Prof. Alexander Clouvas, Aristotelian University of Thessaloniki, Dept. of Electrical and Computer Eng., Nuclear Technology Laboratory, Thessaloniki, Greece
    Prof. Andrej Likar
14. Traceability assurance in standard dosimetry laboratories
    Branko Vegić, Institut "Ruđer Bošković", Služba za zaštitu od zračenja od zračenja i Zavod za kemiju materijala, Laboratorij za radijacijsku kemiju i dozimetriju, Zagreb, Croatia
    Dr. Matjaž Štuhec
15. Depth Concentration Profiling of Hydrogen and Other Light Elements in Thin Films by Elastic Recoil Detection Analysis (ERDA)
    BI-HR/04-05-028
    Dr. Ivančica Bogdanović Radović, Institut "Ruđer Bošković", Zagreb, Croatia
    Asst. Prof. Primož Pelicon
16. Stream Sediments as Indicators of Rock Weathering and Possible Anthropogenic Pollution
    Dr. Halka Bilinski, Institut "Ruđer Bošković", Zagreb, Croatia
    Dr. Darko Hanžel
17. Correlation of Electronic and Structural Properties in Ultrathin Films and Overlayers
    BI-IT/02-05-026
    Prof. Alberto Morgante, Laboratorio TASC-INFM, AREA Science Park, Bazovica, Italy
    Asst. Prof. Dean Cvetko
18. EXAFS Analysis of the B-site Ion Disorder in the Paraelectric Phase of Strontium Titanate ($SrTiO_3$)
    RII3-CT-2004-506008; No. 2005156
    Luca Olivi, ELETTRA, Sincrotrone Trieste S.c.p.A., AREA Science Park, Bazovica, Italy
    Prof. Iztok Arčon
19. XAS Studies of Ti, Mn and Fe Cations Local Environment in Catalysts for Oxidation Reactions RII3-CT-2004-506008
    No. 2005247
    Luca Olivi, ELETTRA, Sincrotrone Trieste S.c.p.A., AREA Science Park, Bazovica, Italy
    Dr. Nataša Novak Tusar, Nacionalni inštitut za kemijo, Ljubljana, Slovenia
    Prof. Iztok Arčon
20. High-resolution X-ray Spectroscopy as a Tool for Studying Inner-shell Atomic Processes and its Potential Analytical Applications
    BI-HU/04-05-013
    Prof. Karoly Tokesi, Institute of Nuclear Research of The Hungarian Academy of Sciences, Debrecen, Hungary
    Dr. Matjaž Kavčič
21. Atomic Absorption in the L-edge Region
    II-04-065 EC
    Prof. Jochen R. Schneider, Dr. Konstantin Klementiev, Synchrotron Laboratory (Synchrotron Radiation Facility) HASYLAB (Hamburger Synchrotronstrahlungslabor), DESY (Deutsches Elektronen Synchrotron), Hamburg, Germany
    Prof. Alojz Kodre
22. Development of Java GUI's for Use in DESY Accelerator Control
    M. Clausen, DESY (Deutsches Elektronen Synchrotron), Hamburg, Germany
    Dr. Mark Pleško
23. Meson Degrees of Freedom on Light Baryons
    BI-PT-04-06-015
    Prof. dr. Manuel Fiolhais, Departamento de Fisica, Universidade de Coimbra, Coimbra, Portugal
    Asst. Prof. Simon Širca, Prof. Bojan Golli
24. NAA and PIXE Techniques for Microcharacterization of Trace Elements and their Species in Environmental Samples
    BI-PT/04-06-010
    Dr. Miguel Reis, Instituto Technologico e Nuclear (ITN), Sacavem, Portugal
    Dr. Matjaž Kavčič, Asst. Prof. Zvonka Jeran
25. Electron-molecule collisions – ions from dissociative processes
    BI-SC/04-05-023
    Dr. Dragutin Šević, Institut za fiziku, Zemun, Serbia and Montenegro
    Dr. Iztok Čadež
26. Preparation and Characterisation of Ternary Metallic Nitride Coatings and Duplex Structures with Improved Corrosion and Oxidation Resistance
    BI-ES/04-05-010
    Dr. José Francisco Marco Sanz, Instituto de Química-Física "Rocasolano", Consejo Superior de Investigaciones Científicas, c/ Serrano, Madrid, Spain
    Dr. Darko Hanžel
27. Degradation and Stabilisation of Iron Gall Ink Containing Paper
    SRS Reference Number(s) 45330
    Prof. E. Pantos, Synchrotron SRS, Daresbury Laboratory, Warrington, Cheshire, Great Britain
    Dr. Jana Kolar, Narodna in univerzitetna knjižnica, Ljubljana, Slovenia
    Prof. Iztok Arčon
28. In Situ Monitoring Approaches for Soils Contaminated with Arsenic and Other Toxic Element
    PSP 21/2005 (British Council Project)
    Prof. Hylke J. Glass, University of Exeter, Camborne School of Mines, Tremough Campus, Cornwall, Great Britain
    Prof. Iztok Arčon, Dr. Zdenka Šlejkovec
29. Spectroscopy Near Proton Drip Line
    BI-US/04-05/10
    Dr. Dariusz Seweryniak, Argonne National Laboratory, Argonne, IL, USA
    Dr. Matej Lipoglavšek
30. Studies of the Neutron Electric Form-factor and NN-correlations at Short Distances
    BI-US/04-05/9
    Dr. Shalev Gilad, Massachusetts Institute of Technology (MIT), Cambridge, MA, USA
    Asst. Prof. Simon Širca

# R & D GRANTS AND CONTRACTS

1. Study of thin organic films and nanostructured materials by synchrotron
   Asst. Prof. Dejan Cvetko
2. In Beam Spectroscopy
   Dr. Matej Lipoglavšek
3. Processes with vibrationally excited molecules
   Dr. Iztok Čadež
4. Fusion relevant research of plasma interaction with surfaces
   Asst. Prof. Primož Pelicon

5. Non-destructive analytical methods as a basis of historical and art-historical researc
   Prof. Žiga Šmit
6. Tolerance of organisms in stressed ecosystems and potential for remediation
   Asst. Prof. Primož Pelicon
7. Development and itroduction of new analisys methods in gamma-ray
   Dr. Matjaž Aleš Korun
8. Inventary of Secovlje saltpan flora and optimisation of growth of autochtonus Salicornia species
   Dr. Marijan Nečemer
9. Evaluation of peak areas and their uncertainties in gamma-ray spectrometry
   Dr. Matjaž Aleš Korun
10. Dating of Waters by H-3 and Pb-210: groundwater dynamics and vulnerability of deep aquifers
    Dr. Jasmina Kožar Logar
11. Application of x-ray analytical techniques
    Dr. Peter Kump
12. Development of environmental information system for monitoring and modelling of spreading of radiological, biological and chemical pollutants in the atmosphere
    Dr. Benjamin Zorko

# RESEARCH PROGRAMS

1. Structure of hadronic systems
   Asst. Prof. Simon Širca
2. Studies of atoms, molecules and structures with photons and particles
   Asst. Prof. Matjaž Žitnik
3. Mobile archaeological heritage: archaeological and archaeometric investigations
   Prof. Žiga Šmit

# NEW CONTRACTS

1. Measurement of gamma-raynemitters in feed and foffer
   Ministrstvo za kmetijstvo,gozdarstvo in prehrano
   Denis Glavič Cindro, M. Sc.
2. Monitoring of radioactivity on drinking water
   Ministrstvo za zdravje
   Denis Glavič Cindro, M. Sc.
3. ELMU 2005
   Ministrstvo za obrambo
   Denis Glavič Cindro, M. Sc.
4. Monitoring of radioactivity of water and external radition
   Ministrstvo za okolje in prostor
   Denis Glavič Cindro, M. Sc.
5. Outdoor radon concentration in Slovenia
   Ministrstvo za okolje in prostor
   Sandi Gobec
6. Off-site monitoring of the Krško NPP in the year 2005
   Nuklearna elektrarna Krško
   Dr. Matjaž Aleš Korun
7. Evaluation of peak areas and their uncertainties in gamma-ray spectrometry
   Ames, d. o. o.
   Dr. Matjaž Aleš Korun
8. Flow meter development
   Gorenje, d. d.
   Dr. Matej Lipoglavšek
9. Monitoring of Central LILW Storage Facility at Brinje
   Agencija za radioaktivne odpadke
   Dr. Marijan Nečemer
10. Maintenance of measurement traceability of reference standards
    Urad za meroslovje
    Dr. Matjaž Štuhec
11. Calibration of radiation monitors
    Ministrstvo za obrambo
    Dr. Matjaž Štuhec
12. Personal dosimetry with TLD-05 dosemeters
    Onkološki institut Ljubljana
    Dr. Benjamin Zorko

# VISITORS FROM ABROAD

1. Prof. Nikos Kallithrakas Kontos and Prof. Tasos Katsanos, Technical University, Kreta, Greece, 23.–26. 03. 2005
2. Dr. Robin Ferdinand, accelerator leader of the project ASCLEPIOS GANIL and CEA-Saclay, 22. 04. 2005
3. Dr. Marion Leonard Manga, Tropical Pesticides Research Institute, Arusha, United Republic of Tanzania, 11. 05.–08. 08. 2005
4. Mr. Reinhard Bacher, Deutsches Elektronen Synchrotron (DESY), Hamburg, Germany, 19. 05. 2005
5. Mr. Andriy Alexandrovich Sizov, Interdisciplinary Scientific and Technical Centre Shelter, Chernobyl, Ukraine, 03. 06.–03. 09. 2005
6. Dr. Fabian Naab, IBMAL, Dept. of Physics, University of North Texas, Denton, USA, 07.–10. 07. 2005
7. Prof. Jerome L. Duggan, IBMAL, Dept. of Physics, University of North Texas, Denton, USA, 08. 07. 2005
8. Dr. Karoly Tokesi, ATOMKI, Debrecen, Hungary, 17.–23. 10. 2005
9. Dr. Darko Tibljaš, PMF, Zagreb, Croatia, 07.–08. 11. 2005
10. Dr. Halka Bilinski and dr. Stanislav Frančišković-Bilinski, Ruđer Bošković Institute, Zagreb, Croatia, 07.–10. 11. 2005
11. Dr. Bratislav Marinković, Institute for Physics, Belgrade, Serbia and Montenegro, 14.–3. 11. 2005
12. Dr. Dirk Arnold, Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany, 14. 11. 2005
13. Dr. Jose Marco and Dr. Ramon Gancedo, Institut Rocasolano, CSIC, Madrid, Spain, 14.–1. 11. 2005
14. Mr. Elmaddin Guliyev, Institute of Radiation Problems of National Academy of Sciences of Azerbaijan, Baku, Azerbaijan, 14. 11.–15. 12. 2005
15. Dr. Pascal Lablanquie and Dr. Francis Penent, Laboratoire de chimie physique – matiere et rayonnement, Universite Pierre et Marie Curie, Paris, France, 21. 11.–04. 12. 2005

# STAFF

**Researchers**

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3. Dr. Iztok Čadež
4. Dr. Darko Hanžel
5. Prof. Alojzij Franc Kodre*
6. Dr. Matjaž Aleš Korun
7. Dr. Peter Kump
8. Prof. Andrej Likar*
9. **Dr. Matej Lipoglavšek**, Head**
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11. Dr. Marijan Nečemer
12. Asst. Prof. Primož Pelicon**
13. Dr. Mark Pleško
14. Prof. Milan Potokar
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21. Dr. Tim Vidmar
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24. Sabina Markelj, B. Sc.
25. Andrej Mihelič**, B. Sc.
26. Dr. Jurij Simčič
27. Matjaž Vencelj, M. Sc.

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29. Matjaž Mihelič, M. Sc.
30. Zdravko Rupnik, M. Sc.
31. Dr. Matjaž Štuhec
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# DEPARTMENT OF THIN FILMS AND SURFACES F-3

***The main field of research of the Department of Thin Films and Surfaces is the development, deposition and characterization of hard protective PVD coatings, while research is also done in the fields of thin films and surface physics. Basic research is concentrated on the study of the physical and chemical properties of various binary, multi-component, and multilayer coatings, as well as the study of heat-treatment processes. In applied research, different coatings are developed for the protection of tools used within various industrial production processes.***

Head:
***Dr. Peter Panjan***

In the year 2005 we continued the research and development of multilayer coatings with modulation periods in the nanometre range. Aside from the work already begun on the TiN/TiAlN system, we also studied the CrN/TiAlN system. By changing the substrate rotation rate we deposited coatings with various modulation periods; in extreme cases we managed to reach layer thicknesses below 20 nm. Using triple rotation of substrates we managed to deposit different aperiodic sequences of layers, which was confirmed by computer simulations. In this way we are able to forecast in advance the depth profile and indirectly estimate the mechanical properties. The basic motivation for this research is to deposit coatings with enhanced toughness. Part of this work was conducted within the scope of the "Nanosciences and nanotechnology" centre of excellence.

In addition to the deposition of coatings in the nanometre range, their characterization is also important. Using a nanoindenter we tested three methods for depth profiling the mechanical properties of thin films. On selected hard coatings we measured the nanohardness depth profile in three ways: (1) by changing the load, (2) by measurement of the perpendicular cross-section, (3) by measurement on a low-angle cut.

**This year was marked by the 20th anniversary of the Centre of Hard Coatings, where we deposit protective coatings for industrial partners. To mark this occasion we published the book "Protection of tools with PVD hard coatings".**

The department collaborates intensively with Slovene industry, both in work on joint projects as well as carrying out depositions of coatings on tools for industrial partners. The latter is performed in the Centre of Hard Coatings, which celebrated its 20th anniversary in 2005. This was accompanied by a thematic supplement in the journal Euroteh, several contributions in the press, and by publication of the book "Protection of tools with PVD hard coatings". It presents all the relevant knowledge in this field and is intended both for researchers as well as for technologists in industry.

Application-oriented research was conducted in collaboration with various institutions, both research and industrial. Together with the Faculty of Natural Sciences and Engineering (University of Ljubljana) we analysed the wear of hot forging tools, protected by different surface engineering methods. For the company Kolektor, d. o. o., Idrija, we developed a process for the protection of copper profile drawing dies. The best results were obtained by CrN coating. For the company Končar Alati, d. d., Zagreb, Croatia, we tested several coatings for the protection of

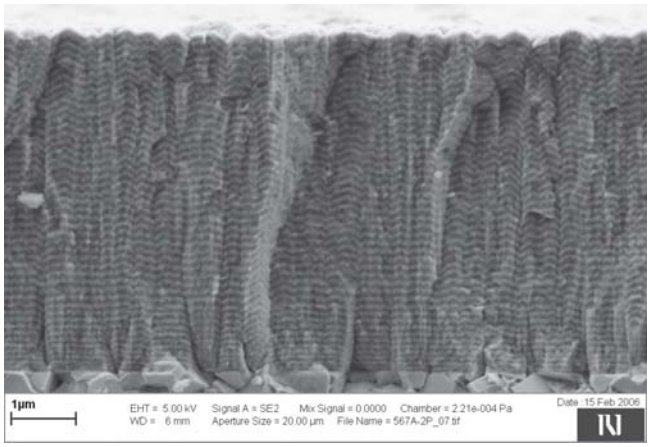


*Figure 1: Fracture cross-sectional SEM micrograph of CrN/TiAlN hard coating in the form of multilayer structure with modulation period on the nanometre scale.*

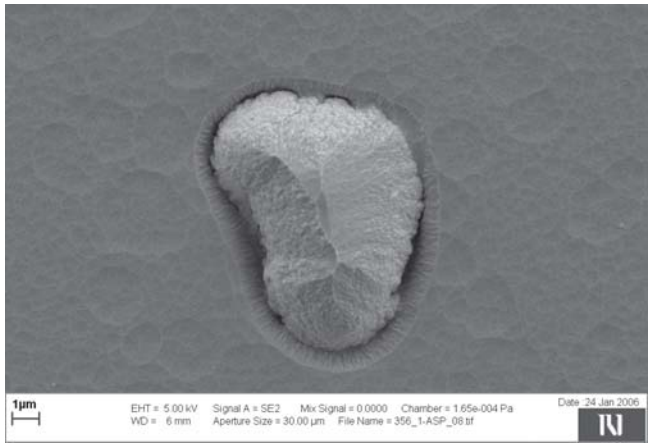


*Figure 2: Microscopic defect in CrN hard coating deposited on a polished substrate made of sintered high speed steel ASP30. Such defects deteriorate the corrosion resistance of hard coatings.*

*Figure 3: Low-pressure plasma in deposition system Sputron with thermoionic arc.*

tools for cold forming of sheet metal. The work included detailed characterization of different coatings and comparative analysis. In collaboration with the Faculty of Mechanical Engineering (University of Ljubljana) and the Silesian University of Technology, Gliwice, Poland, we protected ceramic cutting inserts with various hard coatings. In the scope of a Eureka project with the Faculty of Mechanical Engineering and the company TCG Unitech LTH-OL, d. o. o., Škofja Loka, Slovenia, we studied the protection of laser sintered tools for die casting of aluminium. In another Eureka project, with partners from the Institute of Metals and Technology, Unior, Iskra Mehanizmi, and four other countries, we are studying the wear resistance of steels prepared by conventional sintering.

In the beginning of 2005 the project "Smart quasicrystals" (5. European framework program) finished. Within this project we developed Al-Cu-Fe coatings. When applied as a top layer on TiAlN-covered hard metal cutting plate, its lifetime was improved. Because of these positive results the partners applied for another industrial project to implement this coating in serial production. In summer 2005 the project "Complex metallic alloys" (6. European framework program, network of excellence) started, with our department collaborating as a partner. The project is partly a continuation of the above mentioned project "Smart quasicrystals", but with a broader scope. In addition, we have made preliminary studies of the system Al-Cr-Fe, primarily on the diffusion processes in bilayer structures.

In 2005 we participated in two bilateral projects. With the Institute of Physics, Prague, we researched mass and energy distribution of samples in plasma during the different phases of hard coating deposition. The main emphasis was on TiC coatings. With the Institute of Nuclear Sciences "Vinča" we are working on laser modification of solid state surfaces. Our contribution is the preparation of coatings and the characterization of surface defects in the areas of laser interaction. In addition to these projects we informally collaborate with the Hungarian Academy of Sciences in the fields of sputtering, ion mixing, and the study of processes on phase boundaries of various thin-film systems (Co/Cu, Ta/C). Within this work our contribution is the deposition of thin films with the required thickness and composition. Informal collaboration also exists with the Instituto de Química-Física Rocasolano, Madrid, Spain. This work is focused on the corrosion protection of hard coatings; our task is the deposition of various bi- and multilayers composed of different metal, nitride and oxide films.

*Figure 4: Laser sintered tool for die casting of aluminium alloys protected with TiAlN hard coating.*

## Some outstanding publications in the past three years


1. P. Panjan, M. Čekada, B. Navinšek
   A new experimental method for studying the cracking behaviour of PVD multilayer coatings, Surf. Coat. Technol., 174–175 (2003) 55–62
2. M. Čekada, M. Maček, D. Kek Merl, P. Panjan
   Properties of Cr(C,N) hard coatings deposited in Ar–$C_2H_2$–$N_2$ plasma, Thin Solid Films, 433 (2003) 174–179
3. M. Čekada, P. Panjan, D. Jurić, J. Dolinšek, A. Zalar
   Deposition and characterisation of Al–Cu–Fe thin films, Thin solid films, 459 (2004) 267–270
4. M. Maček, M. Mišina, M. Čekada, P. Panjan
   Energy-resolved mass spectroscopy studies during the deposition of TiC films by ion-plating under different magnetic fields, Vacuum 80 (2005) 184–188
5. P. Panjan, D. Dolinšek, M. Dolinšek, M. Čekada, M. Škarabot
   Improvement of laser sintered tools with PVD coatings, Surf. Coat. Technol., 200 (2005) 712–716


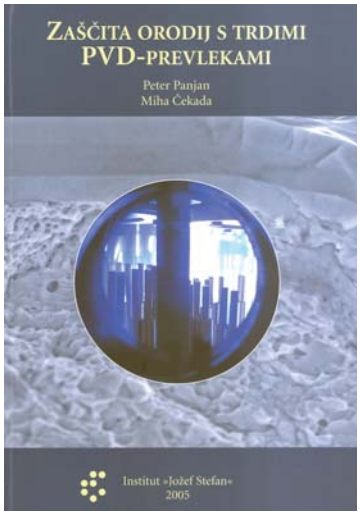


*Figure 5: Front cover of the book "Protection of tools with hard PVD coatings"*

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6. Darinka Kek Merl: Elektropoliranje. Vakuumist, Let. 25, št. 4, str. 34, 2005.
7. Marta Klanjšek Gunde, Matjaž Kunaver, Anton Hrovat, Miha Čekada, Miran Mozetič, Peter Panjan: Analiza površin matiranih praškastih premazov. Vakuumist, Let. 25, No. 1/2, pp. 4-8, 2005.
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16. Matjaž Panjan, Miha Čekada: Merjenje mikrotrdote trdih PVD-prevlek z nanoindenterjem. 1. del. Part 2. Vakuumist, Let. 25, No. 4, pp. 9-17, 2005.
17. Peter Panjan: Kratka zgodovina trdih zaščitnih prevlek. Euroteh (Trzin), Let. 4, pp. 54-59, 2005.
18. Peter Panjan, Miha Čekada: Magnetronsko naprševanje tankih plasti. Vakuumist, Let. 25, No. 4, pp. 18-22, 2005.


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1. Peter Panjan, Miha Čekada: Zaščita orodij s trdimi PVD-prevlekami: Ljubljana, Institut "Jozef Stefan", 2005.


## PUBLISHED CONFERENCE PAPERS

### Regular Papers


1. Đ. Goršćak, Peter Panjan, Miha Čekada, L. Ćurković: Comparison of mechanical properties of various PVD hard coatings for forming tools. 1st International Conference on Heat Treatment and Surface Engineering of Tools and Dies, Pula, 8-11 June, 2005: proceedings, Božo Smoljan, ed., Heimo Jäger, ed., Vojteh Leskovšek, ed., Zagreb, Croatian Society for Heat Treatment and Surface Engineering, 2005, pp. 211-216.
2. Peter Jurči, Peter Panjan: Surface processing of the vanadis 6 steel with plasma nitriding and CrN PVD -coating. PM in Prague, new opportunities in a new Europe : EURO PM2005, congress & exhibition : 2-5 October 2005, Prague, Czech Republic, [S.l.], EPMA 2005, 11 p.
3. Mirko Soković, J. Mikula, Leszek A. Dobrzański, Janez Kopač, Ladislav Kosec, Peter Panjan, Jan Madejski, Andrzej Piech: Cutting properties of the $Al_2O_3$ + $SiC_{(w)}$ based tool ceramic reinforced with the PVD and CVD wear-resistant coatings. Proceedings of the 13th International Scientific Conference Achievements in Mechanical & Materials Engineering, AMME'2005, Gliwice-Wisla, Poland, May 16-19, 2005, Leszek A. Dobrzański, ed., Gliwice, Silesian University of Technology, Institute of Engineering Materials and Biomaterials, 2005, pp. 605-610.
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7. Peter Panjan, Miha Čekada, Darinka Kek Merl: Diamantu podobne prevleke za zaščito orodij in strojnih delov. Odličnost orodjarn: dobavitelj - kupec - orodjar: zbornik posvetovanja, Portorož, 11.-13. oktober 2005, Andrej Polajnar, ed., Janez Poje, ed., Mihael Junkar, ed., Ljubljana, GZS, Združenje kovinske industrije, Odbor za orodjarstvo, v Mariboru, Fakulteta za strojništvo, 2005, pp. 145-149.


## TEXTBOOKS AND LECTURE NOTES


1. Peter Panjan, Miha Čekada: Sodobni postopki zaščite površin orodij in strojnih delov. Zbirka TECOS seminarji za proizvodnjo orodij, PO 40, Celje, TECOS - Razvojni center orodjarstva Slovenije, 2005.


## THESIS

### B. Sc. Thesis

1. Matjaž Panjan: Mechanical properties of nitride hard coatings in nanometre range (Janez Dolinšek, Miha Čekada)

# INTERNATIONAL PROJECTS

1. Complex Metallic Alloys
   CMA
   6. FP; NMP3-CT-2005-500140
   EC; Centre National de la Recherche Scientifique, Paris, France
   Dr. Peter Panjan, Prof. Janez Dolinšek, Asst. Prof. Spomenka Kobe
2. Upgrading of Ledeburitic Type Powder Metallurgy (P/M) Tools Steels
   UPTOOLS EUREKA E!2728
   Dr. Peter Jurči, Ecosond, s.r.o, Prague, Czech Republic
   Dr. Peter Panjan
3. Laser Sintered Aluminium Die Casting Tools
   EUREKA E!3372
   Prof. Slavko Dolinšek, University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana, Slovenia
   Dr. Peter Panjan
4. Nano-second Laser Pulse Modification of Materials
   NANOPLAM
   BI-SC/04-05-026
   Dr. Biljana Gaković, Institute for Nuclear Sciences "Vinča", Belgrade, Serbia and Montenegro
   Dr. Peter Panjan

# R & D GRANTS AND CONTRACTS

1. Layered ceramic nanostructures and 2D nanoparticles arrays
   Dr. Peter Panjan, Dr. Miran Čeh
2. Nanostructured surfaces and interlayers
   Dr. Peter Panjan, Prof. Igor Muševič

# RESEARCH PROGRAM

1. Thin film structures and plasma surface engineering
   Dr. Peter Panjan, Prof. Anton Zalar

# NEW CONTRACTS

1. Project EUREKA E!3437 Progressive Surfacing of Metals
   Ministry for higher education, science and technology of the Republic of Slovenia, Ljubljana
   Dr. Peter Panjan
2. Project EUREKA E!3372 Laser sintered aluminium die casting tools
   Ministry for higher education, science and technology of the Republic of Slovenia, Ljubljana
   Dr. Peter Panjan

# VISITORS FROM ABROAD

1. Dr. Lidija Ćurković, Faculty of Mechanical Engineering and Naval Architecture, Zagreb, Croatia, mag. Đurđica Goršćak, Končar-Alati, d. d., Zagreb, Croatia, 2. 3. 2005
2. Dr. Biljana Gaković, dr. Suzana Petrović, Institute for nuclear sciences „Vinča“, Belgrade, Serbia and Montenegro, 10.–15. 7. 2005
3. Herbert Thanner, European Commission, Brussels, Belgium, 1. 9. 2005
4. Dr. Biljana Gaković, dr. Milan Trtica, Institute for nuclear sciences „Vinča“, Belgrade, Serbia and Montenegro, 9.–15. 10. 2005
5. Wolfgang Waldhauser, Joanneum Research, Leoben, Austria, 25. 10. 2005
6. Dr. Gordana Ristić, Institute for nuclear sciences „Vinča“, Belgrade, Serbia and Montenegro, 6.–8. 11. 2005
7. Dr. Lidija Ćurković, Faculty of Mechanical Engineering and Naval Architecture, Zagreb, Croatia, mag. Đurđica Goršćak, Končar-Alati, d. d., Zagreb, Croatia, 22. 11. 2005
8. Carl Stefan Thöne, Absolut Chemie, Rhede, Germany, 7. 12. 2005

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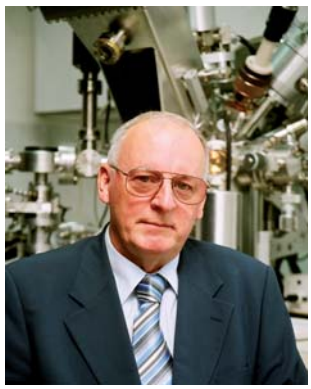
7. Damjan Matelič
8. Andrej Mohar
9. Tomaž Sirnik

* Full-time faculty member

# DEPARTMENT OF SURFACE ENGINEERING AND OPTOELECTRONICS F-4

***The main activities of the Department of Surface Engineering and Optoelectronics are oriented toward surface engineering, surface, interface and thin-film characterization, plasma applications, vacuum optoelectronics, and ultrahigh vacuum techniques and technologies. The department collaborates with other groups at the institute as well as with other Slovenian and foreign institutes, universities and industrial companies. The group is also active in the field of education of students at two Slovenian universities and at the Jožef Stefan international postgraduate school.***



Head:
***Prof. Anton Zalar***

Surfaces, interfaces and thin films of materials are well defined if their elemental composition, chemical state, crystal structure and electronic properties are known. Advanced multilayer structures, composite materials and plasma-treated surfaces are characterised by these properties, all of which can be investigated with various modern analytical techniques. In the department Auger electron spectroscopy (AES) depth profiling has been used successfully, both for basic research and for the characterization of technological samples. In spring 2005 a new X-ray photoelectron spectrometer was installed. X-ray photoelectron spectroscopy (XPS) is one of the most commonly used techniques to determine the elemental composition, chemical state and electronic properties of solid surfaces. The purchase of the XPS spectrometer was supported by the Agency for Research of the Slovenian Republic and eight JSI Departments, which up until now performed their XPS investigations of materials at foreign laboratories. The XPS spectrometer can perform single-point and line-scan analyses, depth profiling, and acquire two-dimensional XPS images. XPS enables the analysis of metals and semiconductors, while a special electron gun on the spectrometer may be used for charge neutralization during the analysis of insulators, such as polymer, textile, and paper samples.

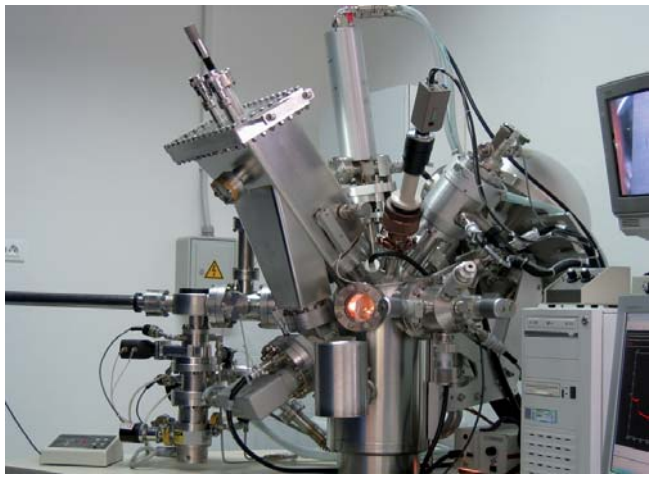


*Figure 1: The new X-ray photoelectron spectrometer installed at the Department of Surface Engineering and Optoelectronics.*

To study the AES sputter depth profiling of layered structures with different layer densities and sputter yields, a bilayer structure of C-graphite/Ta and a multilayer structure of C-graphite/Ni were sputter deposited onto smooth silicon substrates. The profiling was performed at different incidence angles of $Ar^+$ ions in the range 22° to 88°. It was found that the sputtering rates of carbon and both metals, as well as their ratios, are strongly angle-dependent. Unexpectedly, the sputtering rate of carbon at a grazing incidence angle of 82° was found to be approximately the same as those for Ta and Ni. The sputtering-induced surface topography worsens the depth resolution and was studied by atomic force microscopy. The ripple structures formed on the surfaces of carbon layers during sputter depth profiling of stationary samples could be avoided by sample rotation. The measured carbon concentration profile obtained with 1keV $Ar^+$ ions at an angle of incidence of 49° agreed well with the theoretical depth profile calculated by the mixing, roughness, information (MRI) depth model taking into account the backscattering effect of primary electrons.

The study of AES depth profiling of C-graphite/Ni and Co/Cu multilayer structures at grazing ion incidence angles was carried out in co-operation with the Institute for Technical Physics and Materials Science in Budapest. We have shown that if the thickness of at least one of the layers is less than the typical range of ion mixing, then the influence of ion-bombardment-induced roughening due to the difference of the sputtering yields is strongly reduced. The agreement between the experimental relative sputtering yields of $Y_c/Y_{Ni}$ and those obtained by SRIM simulation was excellent up to an incidence angle of 82°.

The development of the X-ray microscope TWINMIC at the synchrotron Elettra in Trieste has been completed. The first tests have been performed in investigations of thin-film structures by high-resolution X-ray microscopy. The results confirmed that the microscope is suitable for non-destructive research on morphology as well as inhomogeneity of bulk materials. X-ray microscopy is a complementary method to electron microscopy. Pb-La-Zr-Ti structures on Si substrates have been investigated

**In the frame of the fifth European framework the new x-ray microscope TWINMIC was developed in collaboration with seven European partners and is now operational at the Elettra synchrotron radiation source in Trieste for applications in the field of materials science, biology and medicine.**

with X-rays perpendicular to the cross-section of the sample. Due to the lateral resolution of the microscope, the thickness of the structure under investigation should be greater than 200 nm. The method proved useful for the study of inhomogeneity and defects in thin-film structures due to the high penetration depth of X-rays. Investigations of MgO particles clearly showed that it was possible to detect particles with a rather low difference of absorption coefficients, thanks to the use of novel detectors and phase contrast methods.

Research on plasma surface engineering was focused on characterization of the products found in the gas phase from the interaction of highly reactive plasmas with the surfaces of polymers, composites and metals. The products were characterized by optical emission spectroscopy, which proved the most suitable method for this research. The research on interaction of plasma with polymers and composites was performed in collaboration with partners from the University Paul Sabatier, Toulouse, France and the Institute of Physics, Zagreb, Croatia, who are well equipped and are among the best groups in the field of optical spectroscopy. In collaboration with partners from the University of Louisville, Kentucky, USA and the University of Perpignan, Font Romeu, France, we performed a study on the influence of oxygen plasmas on metallic materials. Recombination coefficients for various materials have bean measured systematically. This research led to an important discovery: the recombination coefficient of nanostructured materials is always high, at 1, within the limits of experimental error. We also find that long-lived plasma radicals reach the vacuum pump where they react with the oil. In order to prevent this, we developed several catalyst prototypes for plasma radicals, which we mounted on our plasma devices.

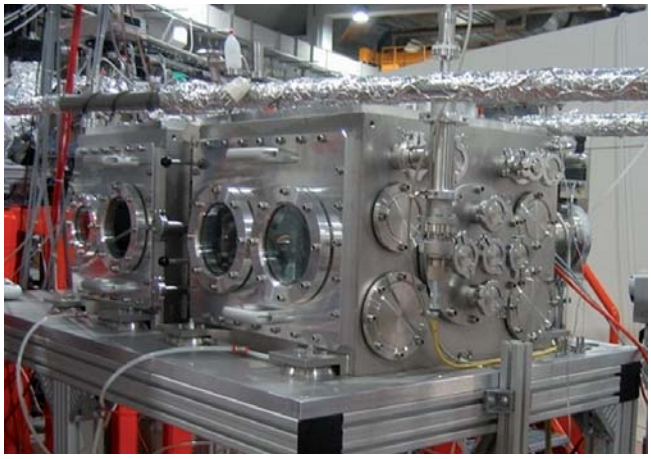


*Figure 2: The transmission x-ray microscope Twinmic, developed and installed at the synchrotron light source, Elettra in Trieste in collaboration with seven European partners and the Department of Surface Engineering and Optoelectronics.*

Research on selective plasma etching and activation of microcomposite materials with a polymer matrix lead to the discovery of the superhydrophilicity of the composite polymer material PPS-graphite (PPS = polymer polyphenyl sulphide). We found that the surface becomes superhydrophilic after exposure to the highly reactive oxygen plasma for a relatively short time. The superhydrophilicity allows for relatively simple deposition and good adhesion of organic materials on such substrates.

Modern analytical methods for investigation of material properties require keeping the sample in ultrahigh vacuum. To reach this pressure range, all walls must be out-gassed well in vacuum, when any volatile surface deposits and dissolved gaseous impurities should be released. In metals, hydrogen is the most abundant dissolved gas which needs to be expelled. Its kinetics of out-gassing are often described by diffusion. At low pressures, models based on diffusion phenomena fail to describe precise measurements at fixed temperatures. In 2005 we carried out experiments where precise permeation data were obtained by an original method. Instead of recording the flow at downstream pressure, we monitored solely the upstream pressure changes. We have shown, by abrupt pressure changes, that all parameters describing the permeation kinetics can be reconstructed. By applying our findings, a simple technique for the selective pumping of hydrogen in high vacuum can be realised by means of a metal membrane.

Field emission of electrons is one of the best evidences of quantum phenomena which has attracted many investigators. They had hoped that several electronic devices with greatly improved performance could be made, ranging from electron microscopes to electronic tubes. Most of expectations ultimately were faced by the crude fact that good lifetimes cannot be obtained for a reasonable effort. Ten years ago, the first reports that carbon nanotubes can exhibit field emission, triggered a new interest for nanostructured materials. They were announced to be easily synthesized, chemically inert, and could thus easily replace thermionic cathodes. So far, cold cathodes are still used in prototype devices rather than in commercial products. In 2005 we showed that the processes induced on the adjacent anode by electrons, greatly change the local pressure in the vicinity of the emitter. It was clearly shown that a UHV environment is not a guarantee for good characterization of specific emitter properties. Namely, the influence of the anode is manifested by a dramatic local pressure change. We have further shown that newly synthesized nanostructured materials ($Mo_6S_3I_6$) represent another promising candidate for field emission cathodes.

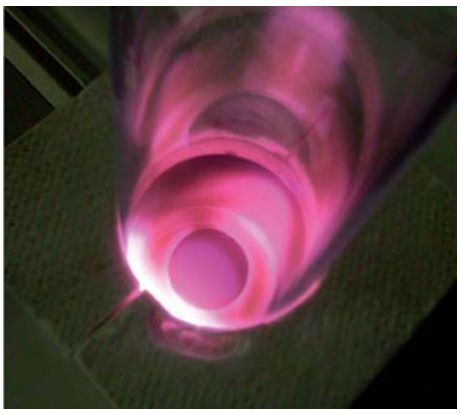


*Figure 3: A sample of non-oxide ceramics during treatment with air plasma.*

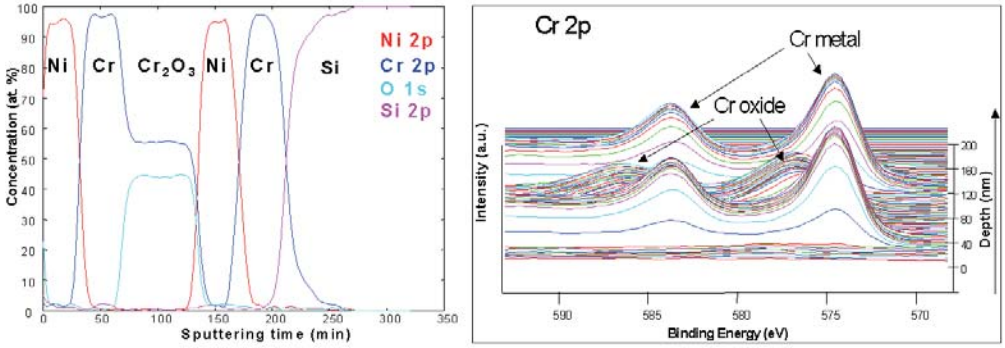



*Figure 4: XPS depth profile (left) and XPS Cr 2p spectra (right), obtained by depth profiling of the Ni/Cr/$Cr_2O_3$/Ni/Cr/Si multilayer structure with a new x-ray photoelectron spectrometer.*

## Some outstanding publications in the past three years

1. A. Zalar, J. Kovač, B. Praček, S. Hofmann, P. Panjan, AES depth profiling and interface analysis of C/Ta bilayers, Applied Surface Science, 252 (2005), 2056-2062
2. J. Kovač, A. Zalar, B. Praček, Quantification of AES depth profiles by the MRI model, Applied Surface Science, 207 (2003), 128-134
3. M. Mozetič, U. Cvelbar, M. K. Sunkara, S. Vaddiraju, A method for the rapid synthesis of large quantities of metal oxide nanowires at low temperatures, Advanced Materials, 17 (2005), 2138-2142
4. M. Mozetič, U Cvelbar, A. Vesel, A. Ricard, D. Babič, I. Poberaj, A diagnostic method for real-time measurements of the density of nitrogen atoms in the postglow of an Ar-$N_2$ discharge using a catalytic probe, Journal of Applied Physics, 97 (2005), 103308-1 - 103308-7
5. B. Zajec, V. Nemanič, Hydrogen pumping by austenitic stainless steel, Journal of Vacuum Science and Technology, A, Vacuum, Surfaces and Films, 23 (2005), 322-329
6. M. Žumer, V. Nemanič, B. Zajec, M. Remškar, M. Ploscaru, D. Vengust, A. Mrzel, D. Mihailović, Field emission of point-electron source $Mo_6S_3I_6$ nanowires, Nanotechnology (Bristol), 16 (2005), 1619-1622

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1. Miran Mozetič, Uroš Cvelbar: Plasma treatment for purifying copper or nickel: PCT patent no. WO 2004/098259 A2: Munich, European Patent Office, 2005.
2. Miran Mozetič, Uroš Cvelbar: Plasmabehandlung zur Reinigung von Kupfer oder Nickel: patent no. C23G 5/00: Munich, Deutsches Patent-und Markenam, 2005.
3. Alenka Vesel, Miran Mozetič: Method and device for measuring of ultrahigh vacuum: PCT patent, no. WO2005/080932 A1: 2005.

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### Regular Papers


1. Uroš Cvelbar, Marta Klanjšek Gunde, Matjaž Kunaver, Miran Mozetič: Weakly ionized oxygen plasma etching of polymer fims and coatings. ISPC 17, 17th International Symposium on Plasma Chemistry, August 7th - 12th, 2005, Toronto, Canada, Toronto, Centre for Advanced Coating Technologies, Faculty of Applied Science and Engineering, University of Toronto, 2005, pp. 761-762.
2. Uroš Cvelbar, Miran Mozetič, Anton Zalar: Aging of plasma treated polymer surfaces. Proceedings, 41th International Conference on Microelectronics, Devices and Materials and the Workshop on Green electronics, September, 14. - September 16. 2005, Ribno, Slovenia, Barbara Malič, ed., Darko Belavič, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2005, pp. 363-366.
3. Aleksander Drenik, Uroš Cvelbar, Alenka Vesel, Miran Mozetič: Research of neutral oxygen atom density in weakly ionized plasma along a side vessel of a plasma reactor. Proceedings, 41th International Conference on Microelectronics, Devices and Materials and the Workshop on Green electronics, September, 14. - September 16. 2005, Ribno, Slovenia, Barbara Malič, ed., Darko Belavič, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2005, pp. 357-362.
4. Janez Kovač, Anton Zalar: Applications of X-ray photoelectron spectroscopy in microelectronics. Proceedings, 41th International Conference on Microelectronics, Devices and Materials and the Workshop on Green electronics, September, 14. - September 16. 2005, Ribno, Slovenia, Barbara Malič, ed., Darko Belavič, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2005, pp. 367-372.
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9. Anton Zalar, Janez Kovač: Spektroskopija Augerjevih elektronov (AES). Posvet o meritvah: 10. in 11. november 2005, Ljubljana, Inštitut Jožef Stefan, 2005, 2 pp.


## THESES

### Ph. D. Theses

1. Uroš Cvelbar: Treatment of Polymer-Graphite Composite Surface with Oxygen Plasma (Prof. Anton Zalar)
2. Bojan Zajec: Thermodynamics and Kinetics of Hydrogen Interaction with the Austenitic Stainless Steel at Low Pressures (Prof. Ladislav Kosec, Prof. Adolf Winkler)

### B. Sc. Thesis

1. Aleksander Drenik: Research of Neutral Oxygen Atom Density in a Side Vessel of a Plasma Reactor (Asst. Prof. Igor Poberaj, Asst. Prof. Miran Mozetič)

## PATENT APPLICATIONS

1. Miran Mozetič, Alenka Vesel, Uroš Cvelbar
   Method and Device for Local Functionalization of Polymer Materials
   Patent application no. P-200500168
2. Vincenc Nemanič, Marko Žumer, Aleš Mrzel, Maja Remškar, Dragan D. Mihailović
   Use of quasi one dimensional transition metal ternary compounds and quasi one dimensional transition metal chalcogenide compounds as electron emitters
   Patent application no. EP 03766800.1, US10/522,740, PCT/SI2003/00027, SI P-200200189

# INTERNATIONAL PROJECTS

1. P3 - Heterogeneous Surface Recombination of Neutral Hydrogen Atoms on Fusion Relevant Materials
   EURATOM – MHST
   6. FP, Fusion Association, EURATOM; FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministrstvo za visoko šolstvo, znanost in tehnologijo, Ljubljana, Slovenia
   Dr. Miran Mozetič
2. Safe Production and Use of Nanomaterials
   NANOSAFE2
   6. FP; NMP2-CT-2005-515843
   EC; Commissariat a l"Energie Atomique, Grenoble, France
   Marko Žumer, Asst. Prof. Maja Remškar, Andrej Detela, Asst. Prof. Boris Turk
3. Fullerene-based Opportunities for Robust Engineering: Making Optimised Surfaces for Tribology
   FOREMOST
   6. FP; 515840-2
   EC; Fundacion Tekniker, Eibar, Spain
   Marko Žumer, Asst. Prof. Maja Remškar
4. Improving the Understanding of the Impact of Nanoparticles on Human Health and the Environment
   IMPART
   6. FP; 013968
   EC; Chalex Research Ltd., Torquay, Great Britain
   Dr. Vincenc Nemanič, Asst. Prof. Maja Remškar
5. Multipurpose, Transportable Twin X-ray Microscopy End-station
   TWINMIC
   5. FP; HPRI-CT-2001-50024
   EC; Dr. Maya Kiskinova, Sincrotrone Trieste SCpA, Area Science Park, Bazovica, Trieste, Italy
   Dr. Janez Kovač
6. Plasma Treatment of Metal Samples
   Discharge Cleaning of Corroded Iron Wires
   Plasmait GmbH, Lebring, Austria
   Dr. Miran Mozetič
7. Characterization of reactive plasma
   PROTEUS
   Dr. Andre Richard, CPAT, Universite Paul Sabatier, Toulouse, France
   Dr. Miran Mozetič
8. Characterization of reactive plasma for surface activation of polymer materials
   BI-HR/04-05-018
   Dr. Slobodan Milošević, Institut za fiziku, Zagreb, Croatia
   Dr. Miran Mozetič
9. Nano-scale Phenomena Atop of Inorganic Nanotubes inducing Stable Field Emission
   BI-CN/06-07/11
   Dr. Lian-mao Peng, Institute of Physical Electronics, Peking University, Department of Electronics, PR China
   Dr. Vincenc Nemanič
10. Auger Electron Spectroscopy Depth Profiling of Interfaces
    BI-HU/04-05-014
    Dr. Miklos Menyhard, Research Institute for Technical Physics and Materials Science, Budapest, Hungary
    Prof. Anton Zalar
11. Plasma sterilization of microorganisms
    PlazSter
    BI-SC/04-05-028
    Dr. Marina Bujko, Institut za zdravje Crne gore, Podgorica, Serbia and Montenegro
    Dr. Miran Mozetič
12. Plasma Synthesis of Inorganic Nanowires and Characterization of Nano-composites
    BI-US/04-05/29
    Dr. Mahendra Sunkara, University of Louisville, Department of Chemical Engineering, Louisville, KY, USA
    Dr. Miran Mozetič
13. Study of Field Emission from Nanocrystalline Diamond Films in Sealed Vacuum Devices
    BI-US/04-05/39
    Prof. Robert Nemanich, North Carolina State University (NCSU), Raleigh, NC, USA
    Dr. Vincenc Nemanič

# R & D GRANTS AND CONTRACTS

1. Study of thin organic films and nanostructured materials by synchrotron radiation
   Dr. Janez Kovač
2. Field emission properties of new nanomaterials
   Dr. Vincenc Nemanič
3. Fusion relevant investigation of plasma surface interaction
   Prof. Milan Čerček
4. Electron beam writer with nanometric resolution
   Dr. Vincenc Nemanič
5. Alternative ion getter pumps
   Asst. Prof. Miran Mozetič
6. Research of gas arrester follow current selfextinguishing characteristics
   Dr. Vincenc Nemanič
7. Highly reactive plasma for treatment of advanced composites
   Asst. Prof. Miran Mozetič
8. Plasma sterilisation and functionalization of biocompatible materials
   Asst. Prof. Miran Mozetič
9. Electron beam plotter for nanolithography
   Dr. Vincenc Nemanič
10. Local and systemic effects of articulation of metal components from total hip replacements
    Dr. Ingrid Milošev
11. Nanoelectronics and devices for nanotechnology
    Dr.Vincenc Nemanič

# RESEARCH PROGRAMS

1. Vacuum technique and materials for electronics
   Dr. Vincenc Nemanič
2. Thin film structure and plasma surface engineering
   Prof. Anton Zalar

# NEW CONTRACT

1. Induktio, d. o. o.
   Plasma sterilization
   Asst. Prof. Miran Mozetič

# VISITORS FROM ABROAD

1. Dr. Slobodan Milošević, Nino Čutić, Nikša Krstulović, Institute of Physics, Zagreb, Croatia, several times in the year
2. Dr. Primož Eiselt, Plasmait, Austria, several times in the year
3. Zoran Vratnica, M, Sc. and Danijela Vujošević, M. Sc., Institute for health of Montenegro, Podgorica, Serbia and Montenegro, several times in the year
4. Ludvik Kumar from Kolektor Group Company, collaboration on joint project, several times in the year
5. Prof. Mahendra Sunkara and Dr. Visinthi Sunkara, University of Louisville, Louisville, Kentucky, USA 13.–19. 06. 2005
6. Prof. R. J. Nemanich, North Carolina State University, Raleigh, USA, 17.–20. 09. 2005

# STAFF

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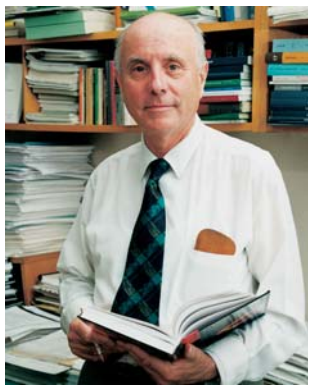
12. Tatjana Filipič, B. Sc.
13. Miha Kocmur
14. Janez Trtnik

** Part-time faculty member

# DEPARTMENT OF SOLID STATE PHYSICS F-5

***Our research program is focused on the study of the structure and dynamics of 'disordered' condensed matter at the atomic and molecular level with special emphasis on phase transitions. The purpose of these investigations is to discover the basic physical laws governing the behaviour of systems that represent the link between perfectly ordered crystals on one side, and amorphous matter, 'soft matter', and living systems on the other. Such knowledge provides the key to the understanding of the macroscopic properties of these systems and is fundamental for the discovery and preparation of new materials for applications. An important part of the research program is devoted to the development of new experimental methods and techniques in the fields of magnetic resonance, magnetic resonance imaging, scanning tunnelling and atomic force microscopy, as well as dielectric relaxation spectroscopy and dynamic specific heat measurements.***



Head:
***Prof. Robert Blinc***

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 2 T, 6 T and 9 T, 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,
- frequency dependent electron paramagnetic resonance (EPR) and 1D and 2D pulsed EPR and relaxation,
- MR imaging and micro-imaging,
- 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 investigations were performed within three research programs:
- NMR and dielectric spectroscopy of condensed matter: smart new materials and translational symmetry breaking,
- physics of soft matter, surfaces, and nanostructures,
- experimental biophysics of complex systems.

The program of the research group **NMR and dielectric spectroscopy of condensed matter: smart new materials and translational symmetry breaking** was focused on investigations of systems with broken translational symmetry such as quasicrystals, organic and inorganic relaxors, disordered perovskite ferroelectrics, and $TiO_2$ nanotubes and spintronic materials.

Whereas in periodic crystals the structure can be determined by X-ray scattering, this is not possible in quasicrystals. The whole crystal is a giant unit cell and the problem of determining the exact structure is not solved yet. One of the important open questions is the distribution of nonequivalent lattice sites in the quasiperiodic structure. We have reported the first observation of the anisotropy of the angular dependence of the quadrupole – perturbed NMR spectra of some nuclei (such as $^{27}$Al) in icosahedral quasicrystals under an external magnetic field. Based on the measured angular dependence, we have determined the local structure. We have also successfully modelled the spin-lattice relaxation in icosahedral quasicrystals. Using a model that considers hopping of the conduction electrons across hierarchically distributed icosahedral clusters, we have succeeded in determining the density of state of conductive electrons close to the Fermi energy level in quasicrystals. These systems are of great interest for hydrogen storage materials. We have succeeded in measuring the self-diffusion coefficient of hydrogen in quasicrystals as a function of

**An important achievement has been the discovery of the origin of the giant electromechanical effect in the relaxors, which is important for many applications, from robotics to medicine. This effect is the result of the existence of a line of critical end points in the phase diagram: temperature-concentration-electric field. Above this line the behaviour is supercritical.**

temperature and hydrogen content. These investigations were also part of the Fifth EU Framework project "Smart Quasicrystals" and are continued in the Sixth EUFP under the network of excellence "Complex Metallic Alloys".

Our investigations have succeeded in elucidating the nature of the giant electromechanical effect in relaxors of the PMN-PT family. We have shown that this effect is the result of a line of critical end points in the temperature-PT concentration-electric field phase diagram. The maximum of the piezoelectric effect as a function of the electric field, occurs at the critical end point for all PT concentrations. Similar effects are found in PLZT and SBN.

Using $^{87}$Sr and $^{47,49}$Ti NMR we have shown that the low temperature properties of strontium titanate (STO) and $^{18}$O enriched STO (STO-18) are determined by the appearance of nanoclusters with broken tetragonal symmetry. In STO-18 these nanoclusters trigger the percolation transition into the ferroelectric phase at $T_c$ = 24 K, whereas the concentration of nanoclusters in STO-16 is too low to induce the percolation transition. This work has been published in Physical Review Letters. Similar nanoclusters have also been found in $BaTiO_3$.

Our investigations of liquid crystalline elastomers showed that the transition from the nematic to the para-nematic phase is determined by the supercritical scenario.

Dielectric investigations of $SrTiO_3$-$O_{18}$ showed that the ferroelectric transition is characterised by classical critical exponents.

We have shown that $TiO_2$ nanotubes can be used for sensors of greenhouse gases. Doping of $TiO_2$ nanotubes induces ferromagnetic properties which are important for spintronics.

In 2005, the results of the research group's investigations have been published in 40 scientific articles in international journals, among which three are in Physical Review Letters. According to the Web of Science, these articles have been cited 440 times in 2005.

The investigations of the research group **Physics of soft matter, surfaces and nanostructures** were focused on photonic crystals, self-organisation of colloids, structural and fluctuation forces, liquid crystals in elastomers, defect and glass structures, applications of liquid crystals, molecular motors, synthesis of inorganic nanotubes, and surface ordered nanostructures.

The problem of the 2D photonic behaviour in colloid systems has been investigated via the study of the phase behaviour of a 2D system of colloid particles in the presence of a commensurate potential with the symmetry of a triangular lattice. The phase transitions from the ordered to the disordered phase have been determined in the molecular field approximation and via Monte Carlo simulations.

The self-organisation of colloids on nanostructured surfaces was studied on free-standing films of the antiferroelectric liquid crystal MHPOBC. The phase sequences and phase transitions in 2-, 3- and 4-layer films have been determined. The measured temperature dependences of the ellipsometric parameters have been compared to the simulations within the phenomenological model of Čepič and Žekš. Self-organisation of colloids into 2D nematic thin films has been experimentally determined.

We have investigated the structural force between a colloidal particle and the focus of the laser tweezers, which is mediated by the nematic director field. An unusual attractive force was observed, although the refractive index of the colloid was smaller than both refractive indices of the nematic. This phenomenon was successfully explained by considering the optical anisotropy of the liquid crystal as well as the deformation of the director field, which is induced either by another colloid or by a strong laser light. The optical tweezers were successfully used. The results led to a new concept in the self-organisation mechanism in nematic colloids, where the interaction with external inhomogeneous fields is important.

A new lattice model of liquid crystal elastomers has been developed that describes qualitatively the orientational ordering of mesogenic units and elastic deformations of the sample. The deuteron NMR and optical properties of the elastomers agree well with this theory.

Within our investigations of the dynamics of perturbed liquid crystalline systems we have analysed the influence of an irregular matrix with mesoscopic pores on the dynamics of the liquid crystals in the isotropic and nematic phases. We have determined the order parameter profile and slowing-down of the molecular dynamics close to the wall. A qualitative explanation of the phase sequences of liquid crystals embedded in controlled porous glasses has been given. We also explained the observed coexistence and dynamics of the structural interface between the Freedericksz domain wall and the disclination lines.

We have developed a new mode of operation of an automatic optical protection filter based on liquid-crystal light modulators. The development was based on computer modelling and laboratory evaluation of the prototypes. The new mode of operation provides for continuous light attenuation over an extremely large interval of optical transmission. It is also important that the new mode of operation retains good angular dependence of the optical contrast in the closed state. It is at least three times better than the requirement of the EN 379 international standard. These results have been further developed within the spin-off company BALDER d. o. o.

The investigations of molecular motors have been focused on oscillatory motions. It has been shown that a new interaction emerges as a result of the broken symmetry responsible for the synchronisation of the movements of two objects. The results are important for synchronisation phenomena observed in colloid systems in optical and magnetic tweezers, as well as the explanation of the wave-like motions observed on the surfaces of respiratory organs. The synchronisation investigations have been focused on miosin V.

New types of $MoS_2$ inorganic nanotubes doped with $C_{60}$ have been prepared which have potential applications in solar cells and as microwave absorbers.

An important part of our research work was devoted to the construction and testing of the new, low-temperature, ultra-high-vacuum scanning tunnelling microscope (UHV STM), which will be used for the low-temperature surface manipulation and chemistry of single atoms and molecules. Using a room temperature STM we have observed elastic surface oscillations and surface reconstruction in silver nanorods, epitaxially grown on $MoTe_2$.

**Another achievement to be mentioned is the synthesis of $C_{60}$ $MoS_2$ crystals which have applications in solar cells, as microwave absorbers and as insulator-metal-insulator systems depending on the amount of light irradiation. A new model of the dissolution of blood clots under turbulent flow has been developed which describes the experimental results obtained with NMR imaging.**

Within the program **Experimental biophysics of complex systems** we have to mention:

- EPR characterisation of the domain structure of biological membranes and the importance of the specific lateral domain structure in the process of membrane fusion,
- new developments of EPR spin labels for the characterization of the hydrophilic part of a membrane surface,
- study of free radicals in human skin after IR radiation and the development of antioxidative protective materials,
- determination of lateral and longitudinal velocities of the dissolution of blood clots and their dependences on the velocity of flow of blood plasma through the blood clots via magnetic resonance imaging,
- development of a new method for magnetic resonance imaging determination of the velocity autocorrelation function of fluids in porous systems.

The above research has been supported by a number of international projects financed by the European Union within the Fifth and Sixth Framework as well as NATO. It was also supported within the bilateral Slovenian–USA, Slovenian–German and Slovenian–Greek and other scientific collaborations. International cooperation with the following institutions made the above studies possible.

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- The Ioffe Institute in St. Petersburg, Russia
- The University of Duisburg, the University of Mainz and the University of Saarbrucken 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, Athens, Greece
- The Institute for Biophysics and X-Ray Structure Research of the Academy of Sciences, Graz, Austria
- The Max Delbruck Centre for Molecular medicine in Berlin
- The Dartmouth Medical School, Hanover, NH, USA
- The Mayo Clinic, Rochester, USA

## Some outstanding publications in the past three years

1. M. Remškar, A. Mrzel, A. Jesih, J. Kovač, New composite $MoS_2$-$C_{60}$ crystals, Adv. Mater, 17 (2005), 911-914
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4. A. Lebar, Z. Kutnjak, S. Žumer, H. Finkelmann, A. Sanchez-Ferrer, B. Zalar, Evidence of supercritical behaviour in liquid single crystal elastomers, Phys. Rev. Lett. 94 (2005), 197801
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## Patents granted

1. Milan Bavec, Franc Justin, Janez Ropret in Janez Pirš: Electromagnetic display panel
   Patent no. 2004010, EP 1591985
2. Jožko Cesar in Slavko Pečar
   Solide phase synthesis of amidines and their derivatives and their use for formation of combinatorial libraries
   Patent no. 21559
3. Janez Pirš, Silvija Pirš, Milan Bavec, Franc Justin, Silvano Mendizza in Janez Ropret
   Electromagnetic display panel illumination
   Patent no. 200400128, EP 1591984
4. Janez Seliger, Robert Blinc, Tomaž Apih, Gojmir Lahajnar
   Triple resonance enhanced nuclear quadrupole resonance detection of TNT and other explosives
   Patent no. 21715

## Awards and appointments

1. Zoran Arsov: March 20, 2005, Regional Biophysics Meeting 2005, Zreče, best conference poster
2. Robert Blinc: elected a member of the World Academy of Science and Art, April 2005
3. Marjetka Conradi: November 2005, Alexander Von Humboldt Foundation Research Fellowship
4. Peter Jeglič: November 21, 2005, Pro Natura Award, Bled, Slovenian Foundation Pro Natura and German Foundation Boehringer Ingelheim Fonds
5. Martin Klanjšek: March 23, 2005, Jožef Stefan Golden Emblem Prize for his outstanding Ph. D. thesis
6. Boštjan Zalar: October 23, 2005, Zois 2005 Award for significant scientific contributions to physics of condensed matter, Ljubljana, Slovenia
7. Aleksander Zidanšek: Oktober 2005, Associate Professor of the Club of Rome Norfolk, Virginia, ZDA

## Organization of conferences, congresses and meetings

1. Physics – An Opportunity for Slovenian Economy, Chamber of Commerce and Industry of Slovenia, Ljubljana, 10. May 2005
2. Regional Biophysics Meeting, Terme Zreče, 16. - 20. March 2005

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4. Suzana Kocjančič: Atomic force microscopy study of quasicrystalline surfaces (Janez Dolinšek)
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2. Safe Production and Use of Nanomaterials
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   6. FP; NMP2-CT-2005-515843
   EC; Frederic Schuster, Commissariat a l"Energie Atomique, Grenoble, France
   Asst. Prof. Maja Remškar
3. Fullerene-based Opportunities for Robust Engineering: Making Optimised Surfaces for Tribology
   FOREMOST
   6. FP; 515840-2
   EC; Alberto Alberdi, Fundacion Tekniker, Eibar, Spain
   Asst. Prof. Maja Remškar
4. Improving the Understanding of the Impact of Nanoparticles on Human Health and the Environment
   IMPART
   6. FP; 013968
   EC; Mark Pullinger, Chalex Research Ltd., Torquay, Great Britain
   Asst. Prof. Maja Remškar
5. Applications of Liquid Crystals for Advanced Nanoscale Devices and Optics
   ALCANDO
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   Prof. Janez Dolinšek
8. A Quadrupole Resonance Instrument for the Clearance of Abandoned Minefields
   NATO SfP - Minefield Detection
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   NATO Scientific Affairs Division; Prof. J. A. S. Smith, King's College London, Chemistry Department Strand, London, Great Britain
   Dr. Tomaž Apih
9. Biophysical Characterization of Structural and Functional Properties of Membrane Domains (Rafts) Protein-Lipid Interactions
   COST D22, WG 002/01
   EC; Prof. John Findlay, University of Leeds, School of Biochemistry and Molecular Biology, Leeds,Great Britain; Antoinette Killian, Department of Biochemistry of Membranes, Center for Biomembranes and Lipid Enzymology, Ultrecht University, Utrecht, Netherlands
   Prof. Milan Schara
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11. Inhomogeneous Phases in Colossal Magnetoresistive Manganites
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12. Nano-structured Liquid-crystal Phasis and Phase Transitions
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18. Interaction of Liposomes with Aminoacids and Peptides for Targeted Delivery into the Organism as Studied by ESR
    BI-HR/05-06-032
    Dr. Vesna Noethig-Laslo, Institut "Ruđer Bošković", Zagreb, Croatia
    Dr. Marjeta Šentjurc
19. Investigations of complex metallic alloys and quasicrystals
    BI-HR/05-06-027
    Dr. Ana Smontara, Institut za fiziku, Zagreb, Croatia
    Prof. Janez Dolinšek
20. Field-cycling NMR Study of Complex Liquid Crystalline Systems
    BI-PT-04-06-002
    Prof. Pedro Sebastiao, Centro de Fisica da Materia Condensada da UL, Lizbon, Portugal
    Prof. Marija Jamšek Vilfan
21. Influence of Disorder on Critical Phase Behavior
    BI-ROM-05-07-006
    Prof. Popa-Nita Vlad, Faculty of Physics, University of Bucharest, Bucharest, Romania
    Prof. Samo Kralj
22. Nanotube dihalkogenida prelaznih metala: teorijska i eksperimentalna istrazivanja Nanorganske nanocevke
    BI-SC/04-05-037
    Prof. Milan Damnjanović, Fizicki fakultet, Univerzitet u Beogradu, Serbia and Montenegro
    Asst. Prof. Maja Remškar
23. Microstructural and Electronic of Low-Dimensional Systems
    BI-ES/04-05-008
    Prof. Carlos Otero-Diaz, Instituto de Química-Física "Rocasolano", Consejo Superior de Investigaciones Científicas, c/ Serrano, Madrid, Spain
    Prof. Albert Prodan
24. EPR Investigation of Surface Active Antidepressant Drug - Membrane Interactions
    Prof. Maral Sünnetçiodlu, Hacettepe University, Department of Physics Engineering, Beytepe-Ankara, Turkey
    Dr. Marjeta Šentjurc
25. Insight in the Physical Phenomena behind the Light-induced Anchoring
    BI-UA/05-06-006
    Dr. Nazarenko Vassili, Institute of Physics National Academy of Science of Ukraine, Kiev, Ukraine
    Prof. Igor Muševič
26. ESR Study of One- and Two-dimensional Antiferomagnets with a Spin Gap
    BI-US/04-05/28
    Prof. Louis Claude Brunel, National High Magnetic Field Laboratory, Tallahassee, FL, USA
    Asst. Prof. Denis Arčon
27. Dielectric and Electromechanical Properties of Electroactive Polymer Composites
    BI-US/05-06/001
    Prof. Qiming Zhang, Materials Research Institute, The Pennsylvania State University, University Park, PA, USA
    Dr. Vid Bobnar
28. The role of EPR oximetry in vivo in the investigation of the efficiency of combined topical application of vasodilatator and radiotherapy in tumor treatment
    BI-US/04-05/021
    MD, Prof. Harold Swartz, Dartmouth Medical School, Hanover, NH, USA
    Dr. Marjeta Šentjurc
29. NMR and NQR Measurements of Farmaceutical Products
    Quantum Magnetics Inc., San Diego, California, USA
    Prof. Robert Blinc
30. Improved Visibility of the OCB Mode Device
    444268-P050801
    Carol Toncar, Kent State University, Research & Graduate Studies, Kent, Ohio, USA
    Dr. Janez Pirš

# R & D GRANTS AND CONTRACTS

1. Self-assembly of colloids on patterned solid-liquid interfaces
   Dr. Klemen Kočevar
2. Study of magnetism in new complex materials
   Dr. Denis Arčon
3. Specificity of interaction of some cytolytic proteins with membrane lipid domains
   Dr. Marjeta Šentjurc

4. Extremophiles as a source of novel bioactive substances
   Dr. Marjeta Šentjurc
5. Biophysical processes studied with optical tweezers
   Dr. Andrej Vilfan
6. Study of one- and two-dimensional antiferromagnets with a spin gap
   Dr. Denis Arčon
7. Spectroscopic imaging of mechanical stress fields in mesomorphic elastomers with magnetic resonance
   Dr. Boštjan Zalar
8. Colloidal particles in 2D free standing ferroelectric smectic films
   Prof. Igor Muševič
9. Biosignal transduction and membrane domain structure
   Dr. Janez Štrancar
10. Transport dielectric and thermodynamic properties of nanostructured and novel materials
    Asist. Prof. Zdravko Kutnjak
11. Dielectric spectroscopy of electroactive polymer composites
    Dr. Vid Bobnar
12. MRI research of wood as a material and as a live tissue
    Dr. Mojca Urška Mikac
13. Layered ceramic nanostructures and 2D nanoparticles arrays
    Dr. Albert Prodan
14. Influence of statin drugs to tumor cell grown
    Dr. Mojca Urška Mikac
15. Analysis and optimization on thrombolysis by magnetic resonance microscopy
    Asist. Prof. Igor Serša
16. Quasicrystals as new materials for hydrogen storage
    Prof. Janez Dolinšek, Dr. Martin Klanjšek
17. Influence of low frequency electromagnetic waves on biological systems and possibilities for application in cancer therapy
    Dr. Marjeta Šentjurc
18. Light modulation with LCD light shutters
    Dr. Janez Pirš
19. UHV cryostat for a low-temperature scanning tunneling microscope
    Dr. Albert Prodan
20. New nanomaterials as a support for ecotechnological optimization
    Dr. Polona Umek, Prof. Robert Blinc
21. Magnetic resonance and others spectroscopic methods based new nondestructive testing methods for safe and quality food
    Prof. Gojmir Lahajnar
22. Nuclear quadrupole resonance - a selective method for explosives detection
    Dr. Tomaž Apih
23. Development of photoelectrochemical cells of Groetzel type
    Prof. Igor Muševič
24. Complex materials for new technologies: from soft matter to hard coatings
    Prof. Slobodan Žumer
25. Hybrid materials and structures
    Dr. Vid Bobnar
26. Synthesis of 1D inorganic nanostrucutres, bionanostrucutres and composite preparation
    Dr. Umek Polona
27. Nanostructured surfaces and interfaces
    Prof. Igor Muševič

# RESEARCH PROGRAMS

1. Experimental biophysics of complex systems
   Prof. Milan Valter Schara
2. Physics soft matter, surfaces and nanostructures
   Prof. Slobodan Žumer
3. NMR and dielectric spectroscopy condensed matter: smart new materials and translational symmetry breaking
   Prof. Robert Blinc

# VISITORS FROM ABROAD

1. Janja Milivojević, Iskra Tela, Ljubljana, Slovenia, 1. 1.–31. 12. 2005
2. Prof. Dr. Ivo Šlaus, Institute Rudjer Bošković, Zagreb, Croatia, 12.–13. 1., 14.–15. 2., 1.–2. 3., 19.–21. 4., 29. 6., 8. 8., 10.–11. 10., 20.–21. 10. 2005
3. Prof. Dr. Valentin Laguta, Ukrainian Academy of Sciences, Institute for Problems of Material Science, Department of Oxides Materials, Kiev, Ukraine, 20. 2.–5. 4. 2005
4. Dr. Fanny Milia, National Center for Scientific Research "Demokritos", Institute of Material Science, Aghia Paraskevi Attikis, Greece, 5.–12. 3., 25. 11.–2. 12. 2005
5. Dr. George Cordoyiannis, National Center for Scientific Research "Demokritos", Institute of Material Science, Aghia Paraskevi, Athens, Greece, 7. 3.–31. 12. 2005
6. Prof. Dr. Juergen Eckert, University of California, Materials Research Laboratory, Santa Barbara, California, USA, 8. 3.–19. 5. 2005
7. Prof. Dr. Lawrence Berliner, University of Denver, Chemistry and Biochemistry, Colorado, USA, 20.–23. 3. 2005
8. Prof. Dr. Goran Bačić, University of Belgrade, Institute for Physics Chemistry, Belgrade, Serbia and Montenegro, 21.–23. 3. 2005
9. Prof. Dr. Patrick Judeinstein, University of Paris, Orsay, France, 15. 4. 2005
10. Vishal Pandya, Kent State University, Physics Department, Kent, Ohio, USA, 2.–31. 5., 20. 11.–20. 12. 2005
11. Dr. Sofoklis S. Makridis, National Center for Scientific Research "Demokritos", Institute of Nuclear Technology and Radiation Protection, Athens, Greece, 3.–6. 5. 2005
12. Dr. Vesna Noethig-Laslo, Institute Ruđer Bošković, Zagreb, Croatia, 5. 5. 2005
13. Prof. Dr. Raymond Kind, ETH, Zurich, Switzerland, 9.–15. 5., 11.–15. 7., 6.–9. 12. 2005
14. Prof. Dr. Arcady Levanyuk, Campus de Cantoblanco, Facultad de Ciencias, Departamento de Fisica Materia Condensada, Madrid, Spain, 15.–30. 5. 2005
15. Dr. Luca Quaroni, Elettra, Bazovica, Italy, 17. 5. 2005
16. Dr. Bohdan Lev, National Academy of Science of Ukraine, Kiev, Ukraine, 20. 5.–20. 6. 2005
17. Prof. Dr. Sushanta Dattagupta, S. N. Bose National Centre for Basic Sciences, Salt Lake City, Kolkata, India, 10. 6.–24. 6. 2005
18. Prof. Dr. Norbert Kroo, Hungarian Academy of Sciences, Budapest, Hungary, 22. 6. 2005
19. Dr. Valentina Domenici, Universita di Pisa, Dipartimento di Chimica e Chimica Industriale, Pisa, Italy, 4.–5. 7. 2005
20. Lidija Habjanec and Marija Brgles, Imunološki zavod Zagreb, Croatia, 5.–7. 7. 2005
21. Prof. Dr. Luis Carlos Otero Diaz, University of Madrid, Department of Inorganic Chemistry, Madrid, Spain, 22.–28. 7. 2005
22. Prof. Dr. Tadeusz Walczak, Dartmouth College of Medicine, Hanover, New Hampshire, USA, 21.–30. 8. 2005
23. Dr. Uliana Ognysta and Dr. Andriy Nych, National Academy of Science of Ukraine, Institute of Physics, Kiev, Ukraine, 1.–30. 9. 2005
24. Prof. Dr. Raymond L. Withers, Australian National University, Research School of Chemistry, Canberra, Australia, 1.–9. 9. 2005
25. Prof. Dr. Viktor Aksenov, Joint Institute for Nuclear Research, Dubna, Russia, 6.–18. 9. 2005
26. Prof. Dr. George Nounesis, National Center for Scientific Research "Demokritos", Institute of Radioisotopes and Radiodiagnostic Products, Aghia Paraskevi, Athens, Greece, 16.–21. 9. 2005
27. Sergiy Lazarenko, Radboud University of Nijmegen, IMM Institute, Nijmegen, The Netherlands, 3.–14. 10. 2005
28. Dr. Stephen Blanksby, University of Wollongong, Department of Chemistry, Wollongong, Australia, 14. 10. 2005
29. Prof. Dr. Valentin Vikhnin, A. F. Ioffe Physical Technical Institute, St. Petersburg, Russia, 2.–30. 11. 2005
30. Prof. Dr. David C. Ailion, University of Utah, Department of Physics, Salt Lake City, Utah, USA, 4.–12. 11. 2005
31. Dr. Pedro Sebastiao and Dr. Carlos Cruz, Technical University of Lisbon, Lisbon, Portugal, 13.–20. 11. 2005
32. Prof. Dr. Henry Connor, Kentucky Wesleyan College, Department of Chemistry, Owensboro, KY, USA, 23. 11. 2005
33. Prof. Dr. Maya D. Glinchuk, National Academy of Science, Institute for Problems of Material Science, Kiev, Ukraine, 2.–15. 12. 2005
34. Prof. Dr. James F. Scott, University of Cambridge, Department of Earth Sciences, Cambridge, Great Britain, 13.–16. 12. 2005

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4. Asst. Prof. Vid Bobnar**
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6. Prof. Janez Dolinšek*
7. Dr. Cene Filipič
8. Prof. Nenad Funduk***
9. Prof. Marija Jamšek Vilfan
10. Prof. Samo Kralj*
11. Asst. Prof. Zdravko Kutnjak**
12. Prof. Dr .Gojmir Lahajnar**
13. Prof. Adrijan Levstik
14. Dr. Mojca Urška Mikac

15. Prof. Igor Muševič*
16. Prof. Slavko Pečar*
17. Dr. Janez Pirš
18. Prof. Albert Prodan**
19. Asst. Prof. Maja Remškar**
20. Prof. Milan Valter Schara
21. Prof. Janez Seliger*
22. Asst. Prof. Igor Serša**
23. Prof. Janez Stepišnik*
24. Dr. Marjeta Šentjurc
25. Dr. Miha Škarabot**
26. Asst. Prof. Janez Štrancar**
27. Dr. Herman Josef Petrus Van Midden***
28. Asst. Prof. Boštjan Zalar**
29. Prof. Aleksander Zidanšek**
30. Prof. Slobodan Žumer*

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31. Dr. Zoran Arsov
32. Dr. Marjetka Conradi**
33. Dr. Alan Gregorovič
34. Dr. Peter Jeglič**
35. Dr. Martin Klanjšek**
36. Dr. Klemen Kočevar***
37. Dr. Tilen Koklič
38. Dr. Polona Umek**
39. Dr. Andrej Vilfan
40. Dr. Andrej Zorko**

**Postgraduates**

41. Zrinka Abramović, M. Sc.
42. Iztok Dogša, B. Sc..
43. Andrija Lebar, B. Sc.
44. Bojan Marin***, M. Sc.
45. Matej Pregelj, B. Sc.
46. Uroš Tkalec, B. Sc.
47. Marko Viršek, B. Sc.
48. Dr. Boris Vodopivec**
49. Andrej Vrečko, B. Sc.
50. Stanislav Vrtnik, B. Sc.
51. Blaž Zupančič, B. Sc.
52. Rok Žitko, B. Sc.

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53. Dr. Orest Jarh***
54. Ivan Kvasić, B. Sc.
55. Bojan Ložar, B. Sc.
56. Asst. Prof. Dušan Ponikvar*
57. Mateja Stanislava Rot, B. Sc.
58. Milan Rožmarin
59. Dr. Janez Slak***

**Technical and administrative staff**

*60. Nataša Božović, B. Sc., left 01.05.2005*
61. Dražen Ivanov
62. Mirko Kokole
63. Davorin Kotnik
*64. Marta Lavriša, retired 20. 10. 2005*
65. Silvano Mendizza
66. Marjanca Nemec
67. Iztok Ograjenšek
68. Silvija Pirš
69. Ana Sepe
70. Marjetka Tršinar
71. Veselko Žagar

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

# DEPARTMENT FOR COMPLEX MATTER F-7

***The research within the Department for Complex Matter encompasses a variety of research fields, ranging from the synthesis of new materials to the fundamental investigations of elementary excitations in complex systems. These include anything from nano-biosystems and biomolecules, to superconductors and nanowires. The experimental methods used are suitably diverse, from synthetic chemistry to biomedicine, femtosecond laser spectroscopy and magnetometry. In the last year the research activities on new nanomaterials and nanotechnology, such as nanolithography were greatly expanded, and apart from some important new fundamental science discoveries, some viable applications have also emerged.***

Head:
***Prof. Dragan D. Mihailović***

The activities in the department can be grouped together into a number of thematically inter-related research areas:

**Ultrafast electron dynamics in different systems**

In the field of relaxation processes of photo-excited electrons in strongly correlated electron systems, several experimental studies have been performed using femtosecond time-resolved techniques. The aim of the ongoing research is to obtain additional information about the nature of the low-lying excitations in these materials, which are not accessible with conventional spectroscopic techniques, to elucidate the non-equilibrium phenomena, their advantages and limitations, and to further develop these spectroscopic techniques.

As an important contribution to the overall understanding of the relaxation phenomena in strongly correlated electron systems we should single out the theoretical work discussing carrier relaxation dynamics in materials with a narrow gap in the single particle excitation spectrum. In particular, we have studied the relaxation dynamics within the phenomenological Rothwarf Taylor (RT) model and obtained analytical solutions for limiting cases of strong and weak phonon bottlenecks. Comparison of the model with the experimental data available, shows that the strong phonon bottleneck scenario can account for the experimental data on both conventional as well as high temperature cuprate superconductors. This work has been published in Physical Review Letters 95, 147002 (2005).

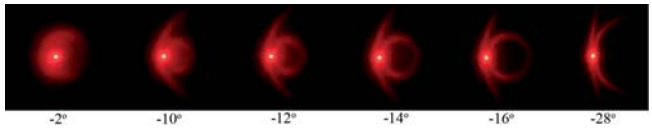


*Figure 1: Holographic scattering from polymer-dispersed liquid crystals (PDLC) observed at different angles of the incident beam. Published in Applied physics letters, 87 (2005) 151101.*

Another important result in the field is establishing the correlation between the timescale of the superconducting state recovery dynamics and the length-scale of the intrinsic inhomogeneities in cuprates. The analysis, and comparison with other more direct spectroscopic probes, suggests that, near the superconducting critical temperature, the characteristic length-scale of the inhomogeneity scales with the superconducting coherence length. This result is important for the overall understanding of superconductivity in cuprates. In addition, the analysis suggests that femtosecond optical spectroscopy can be utilized to determine the typical length-scales in self-assembled nanostructures of various materials. This work has been published in Physical Review Letters 94, 207001 (2005).

**Nonequilibrium phenomena in superconductors have been investigated from various points of view. The analysis of the data on conventional and cuprate superconductors shows that superconducting state recovery is governed by the strong phonon bottleneck in both classes of materials. On the other hand, the analysis of the ballistic transport of nonequilibrium phonons at high temperatures suggests the presence of intrinsic nanometre size inhomogeneities. It is shown that the mesoscopic texturing is a result of structural instability caused by the Jahn-Teller effect and a strong long-range Coulomb repulsion.**

We have continued studying femtosecond carrier relaxation processes in the cuprate superconductor $La_{2-x}Sr_xCuO_4$, focusing on nonlinear effects in a high perturbation regime. In particular, we have studied excitation intensity dependence dynamics as a function of temperature. Laser amplifier was used as a source of high energy pulses, enabling the study of dynamics with excitation density varying over more than four orders of magnitude. In the high excitation density limit, the pulse energy is high enough to completely destroy the superconductivity. On the other hand, at temperatures above the superconducting critical temperature we were able to track the excitation intensity dependence of the relaxation across the pseudogap.

While the main features of the dynamics of photo-excited heavy electron systems were accounted for by the electron-phonon thermalisation mechanism with suppressed e-ph scattering near the Fermi level, several observations were not accounted for by this mechanism. Motivated by strong similarities between the observed carrier relaxation dynamics in heavy electron compounds and

superconductors, we have revisited the problem of carrier relaxation in heavy electron compounds. In particular, we have performed temperature and excitation intensity dependence measurements of carrier relaxation processes in heavy fermion $YbAgCu_4$ and Kondo Insulator $SmB_6$. The results show close agreement with the prediction of the Rothwarf-Taylor model, implying that the carrier relaxation dynamics in this large class of compounds is governed by the presence of a weakly temperature dependent hybridization gap. This work has been published in Physical Review Letters 96, 037401 (2006).

**Theoretical studies at the nanoscale**

We continued with investigations of the lattice-gas model with competing anisotropic Jahn-Teller and isotropic Coulomb interactions by means of Monte-Carlo simulations. Influence of boundary conditions and properties at higher average particle densities were analyzed in more detail. We found that vacancies behave very similar to particles, but the influence of boundary conditions on the characteristic phase separation temperature is more significant at higher average densities. This work has been published in Physical Review Letters 94, 147003 (2005).

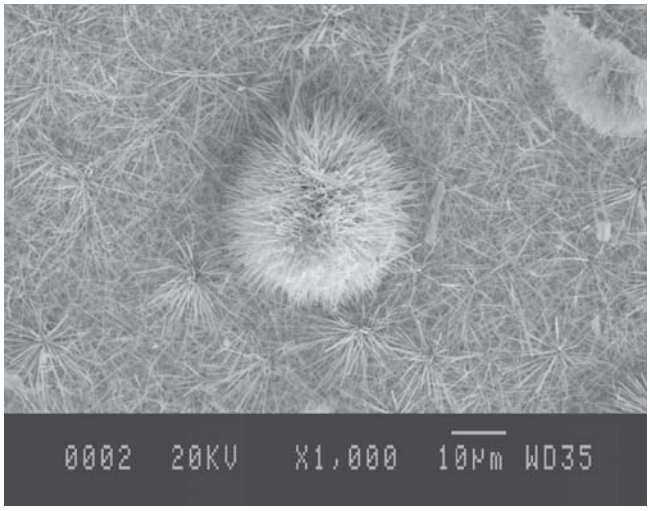


*Figure 2: Recrystallized $Mo_6S_3I_6$ nanowires.*

Analytical expressions for the magnetization and the longitudinal conductivity are derived for metallic nanowires in a magnetic field. We showed that the interplay between size and magnetic field energy-level quantization manifests through novel magnetic quantum oscillations. The amplitude of oscillations is strongly enhanced in the magnetic field that corresponds to the resonance condition. This work has been published in Physical Review Letters 95, 076601 (2005).

**Nanotubes and nanomaterials**

We have further investigated the physical properties of quasi-one-dimensional transition metal, chalcogen, and halogen systems. We have measured the electrical transport properties of bulk $Mo_6S_3I_6$ powder in a pellet form. It was shown that different post-synthesis processes drastically change the measured properties. Recrystallization techniques such as transport synthesis were used to produce more homogenous material. We have optimized the chemical synthesis of $Mo_6S_3I_6$ nanowires where we have shown that a few 100g of the material can be produced per week.

Different compounds of the transition metal, chalcogen, and halogen, quasi-one-dimensional systems have been investigated in detail, using AFM and STM, to construct an organic-inorganic complex system. We have shown that a protein Tyroglobulin can be attached at the ends of the nanowire. In order to measure the transport properties of such novel compounds, we have also successfully scaled down the minimal size of structures, especially electrical circuits, made by e-beam lithography.

**Electron dynamics in biological macromolecules**

In our research on charge dynamics and charge localization in DNA we have upgraded our method of photo-induced infrared absorption. In addition to a conventional FTIR spectrometer we have built a setup for measuring infrared absorption which enables different laser excitation times from a few seconds to a few tenths of a millisecond. With this home-made spectrometer we could measure the lifetimes of photoexcitations in DNA directly. From an amplitude of the photoinduiced signal measured with the FTIR spectrometer we have estimated the lifetime to be $\geq 1$ ms. Direct measurements have shown that the lifetimes are even longer, ranging between 10 ms and 100 ms. We have continued our research with measurements of infrared and photoinduced absorption on synthetic DNA homopolymers (DNA helices composed exclusively of A-T or G-C pairs). Because the available amounts of such materials are limited we had to adapt our method to ten times less material. We did so without significantly reducing sensitivity of the method. In contrast to native DNA, which is a random sequence of base pairs, the DNA homopolymers are much more ordered structures. Therefore for the homopolymers we expect a different (presumably faster) dynamics of the photoinduced charge excitations.

In the second part of our research we have investigate influences of stacking of mononucleotides (building blocks of DNA) in single and double stranded DNA on their optical absorption. A chromophore's optical spectrum is composed of peaks which correspond to dipolar transitions between the chromophore's molecular orbitals. When the chromophore interacts with its surroundings those transitions change both in intensity and position on the energy axis. From those changes we could make conclusions about the nature and intensity of the chromophore's interactions in a particular environment. In the case of DNA we have measured optical absorption spectra of mononucleotides and single and double stranded DNA homopolymers. We have discovered that even for single

stranded DNA, a base stacking effect is strong enough to modify a mononucleotide's spectrum. Since stacking into single or double stranded helices differently effects different optical transitions (enhances some and reduces other), we could detect some previously unobserved optical transitions in the low energy part of the optical absorption spectra.

In the research group **Light and matter** we continued our interdisciplinary studies on the interaction of light and matter, its use in research, and its applications in various fields.

### Soft Matter

Liquid crystal colloids were studied using magneto-optical tweezers. Preliminary results had shown that the strong electric field of the optical tweezers laser beam influences the molecular configuration within the liquid crystal. We avoided this by using magnetic tweezers where a low intensity magnetic field was applied during the measurement. We measured the separation dependence of the force between two micrometer-sized superparamagnetic beads. Due to the elastic deformation in the liquid crystal, the force has a long range. By combining dynamic and static measurements, we obtained the effective drag coefficient as a function of inter-particle separation. We found the coefficient independent of separation for wall-to-wall values as small as 400 nm.

In cooperation with the Institute for Experimental Physics at the University of Vienna, we continued investigations of the diffraction properties of thick H-PDLC transmission gratings. Most of the experimental work was concentrated on optimization of the grating formation process using three-component polymer-LC mixtures. We also studied the effect of external field and temperature on the diffraction properties of the gratings with strong overmodulation of the diffraction efficiency. Measurements of small angle scattering of cold neutrons (SANS, research center GKSS, Gesthacht, Germany) showed that HPDLCs exhibit a photoneutron effect much larger than any holographic material analysed to date. We also accomplished the first systematic characterisation of the holographic scattering process in HPDLCs.

In cooperation with Brown University (Providence, USA) we investigated the electro-optical properties of holographic polymer dispersed liquid crystals (H-PDLC). We analysed the electro-optical response of the transmission gratings in the so called in-plane switching configuration. We investigated the dynamic and optical diffraction properties of photonic quasicrystalline structures made from polymers and liquid crystals. Our results showed that due to the random phases of the writing beams, different diffracted beams exhibit very different electro-optical properties. Dynamic light scattering measurements revealed that the dispersion relation of the thermal orientational fluctuations of the nematic LC phase embedded in periodic or quasiperiodic polymer matrices exhibits a band structure analogous to the phonon and electronic bands in crystals.

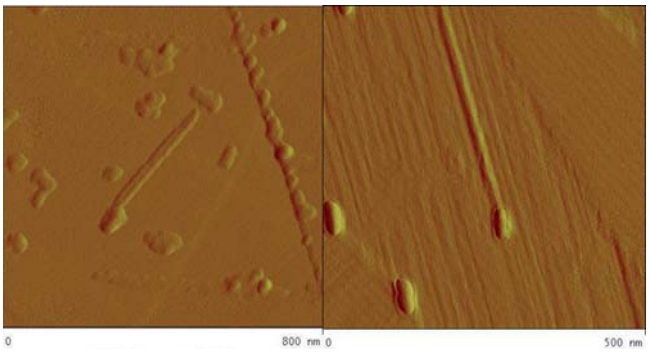


*Figure 3: AFM picture of MoSI nanowires functionalised with thyroglobuline protein. The proteins tend to attach to the end of the nanowires forming a covalent bond.*

Surface optical second harmonic generation (S-SHG) was used to study the switching characteristics of thin films of ferroelectric liquid crystal polymers (FLCP). These films (also called electrically commanded surfaces) represent a promising novel switching concept in LCD technology; however, their fundamental properties are still far from being fully resolved. We analysed the effect of an external electric field on the magnitude of the SHG signal and the dynamic response to switching of the field. This research is carried out in cooperation with the Chalmers & Gothenburg University from Sweden.

In cooperation with University of Ancona in Italy, we continued our research work on self-assembling properties of guanosine derivatives in aqueous solutions. In 2005 the work was redirected to investigation of the surface structures of guanosine 5' monophosphate (GMP) prepared by dip coating from aqueous solution onto mica and silicon substrates. The main analysis of the surface layers was performed by atomic force microscopy (AFM). In addition, preliminary investigations were also made by nonlinear optical sum frequency generation techniques (SFG, AMOLF, Amsterdam, The Netherlands) and by grazing-incidence small angle x-ray scattering (GISAXS, Elettra, Trieste, Italy)

### Biological systems

We continued our research on cytoskeleton proteins (actin) and associated molecular motors. We upgraded the optical tweezers setup so that a wider range of forces on a particle can be achieved during a measurement. The first micro-rheological measurements of protein networks have also been done.

### Nonlinear optics

In the nonlinear optics laboratory we study new materials and their interaction with laser light. We are especially interested in new materials which promise applications in the following highly competitive fields: optical data storage, optical processing and telecommunications. We are also interested in producing compact laser sources in

the eye-safe wavelength region of 1550 nm. In 2004 we cooperated with a company Fotona from Ljubljana and with the National Institute for Materials Science in Tsukuba, Japan, studying the optical properties of domain engineered $LiTaO_3$ crystals with Mg doping of various stoichiometries. These crystals are especially suited for optical parametric conversion from the Nd:YAG wavelength to the eye-safe region.

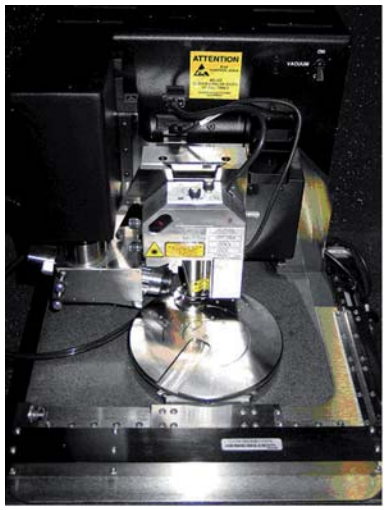


*Figure 4: Probe microscope Dimension 3000, purchased with funds from ESRR, is the most modern microscope in Slovenia. It allows atomic resolution combined with user-friendly operation.*

**Biomedical optics**

We have investigated the potential of pulsed photothermal radiometry techniques for optical profilometry and tomography of the vasculature in human skin, which could help improve our understanding of the laser therapy of port wine stain birthmarks. We have developed an improved numerical algorithm to solve the related inverse problem. Using the algorithm, we have developed a detailed numerical simulation to investigate the influence of several experimental parameters (e.g., infrared detector technology, spectral band and frequency of signal acquisition, selection of optimal effective absorption coefficient) on the accuracy and reliability of the temperature profile reconstruction in human skin. To that end, we also used a numerical model of optical and thermal transport based on port wine stain biopsy.

In collaboration with Beckman Laser Institute (BLI) at University of California, Irvine (UCI), we have tested the system performance and predicted dependencies in experimental tests involving animal models and volunteer patients. We have also demonstrated that temperature stabilization of the infrared lens is necessary to ensure accurate PPTR profiling results.

In collaboration with the Clinical Centre Ljubljana (Department for Plastic Surgery and Burns), we performed clinical trials of laser therapy of some dermatologic lesions - primarily port-wine stains and keloid scars –including a dual-wavelength prototype laser system fitted with a dynamic cryogen cooling device (by Fotona d.d., Ljubljana).

*Figure 5: Coherent laser system used as a source of ultra-fast laser pulses shorter than 100fs. It consists of two frequency doubled NdYag lasers (rear of the picture) used for pumping. Laser oscillator (in the middle) uses Kerr-Effect for stable self mode-locked operation giving pulses at high repetition rates, and Regenerative Laser Amplifier (front) amplifies pulses up to a few J per pulse at 300kHz.*

**New experimental methods**

We have developed the technology and a working prototype for the magnetic manipulation of superparamagnetic colloidal particles. The aim of the work was to upgrade the existing laser tweezer setup giving us the potential to perform qualitatively new experiments. The magnetic manipulation system consists of three orthogonal Helmholz coils pairs, a six-channel computer controlled precision current source, and application software. The system can generate arbitrary time- and space-varying magnetic fields within a wide range of experimentally relevant values. An important feature of the system is that both attractive and repulsive magnetic forces between superparamagnetic colloidal particles can be produced by choosing the right combination of control parameters. The magnetic system was used to study interactions between colloidal particles dispersed in liquid crystals. The main advantage of using magnetic particle manipulation in liquid crystals is that the magnetic field does not induce the distortion of a director field that is normally produced by the high intensity laser beams used for laser trapping.

## Some outstanding publications in the year 2005

1. Ellabban, M. A., Fally, M., Uršič, Hana, Drevenšek Olenik, Irena. Holographic scattering in photopolymer-dispersed liquid crystals. Appl. phys. lett., 2005, 87, pp. 151101-1-3.
2. Aleksandrov, A. S., Kabanov, Viktor V. Magnetic quantum oscillations in nanowires. Phys. rev. lett., 2005, vol. 95, pp. 076601-1-076601-4.
3. Kabanov, Viktor V., Demšar, Jure, Mihailović, Dragan. Kinetics of a superconductor excited with a femtosecond optical pulse. Phys. rev. lett., 2005, vol. 95, pp. 147002-1-147002-4.

4. Mertelj, Tomaž, Kabanov, Viktor V., Mihailović, Dragan. Charged particles on a two-dimensional lattice subject to anisotropic Jahn-Teller interactions. Phys. rev. lett., 2005, vol. 94, pp. 147003-1-147003-4.
5. Mihailović, Dragan. Optical experimental evidence for a universal length scale for the dynamic charge inhomogeneity of cuprate superconductors. Phys. rev. lett., 2005, vol. 94, pp. 207001-1-207001-4.
6. Remškar, Maja, Mrzel, Aleš, Jesih, Adolf, Kovač, Janez. New composite $MoS_2$-$C_{60}$ crystals. Adv. mater. (Weinh.), 2005, vol. 17, pp. 911-914.
7. Stenovec, Matjaž, Poberaj, Igor, Kreft, Marko, Zorec, Robert. Concentration-dependent staining of lactotroph vesicles by FM 4-64. Biophys. j., 2005, Vol. 88, No. 4, pp. 2607-2613.
8. Wong, Alan, Ramsey, Ida, Spindler, Lea, Wu, Gang. Disodium guanosine 5'-monophosphate self-associates into nanoscale cylinders at pH 8: a combined diffusion NMR spectroscopy and dynamic light scattering study. J. Am. Chem. Soc., 2005, vol. 127, no. 19, pp. 6990-6998.
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## Patents granted

1. Marko Kreft, Sonja Grilc, Igor Poberaj, Helena Chowdhury Haque, Robert Zorec
   Procedure for evaluation of hybridoma cell fraction and cell products using confocal microscopy and autoclavable electrofusion cell
   Patent no. 21661

## Organization of conferences, congresses and meetings

1. DESYGN-IT Meeting, Bled, Slovenia, 15. 09. – 16. 09. 2005.
2. NANOTEMP Meeting, Bled, Slovenia, 20. 09. – 21. 09. 2005.
3. SLONANO 2005 : 4$^{th}$ Symposium of Science and Technology of Nanomaterials in Slovenia, Ljubljana, Slovenia, 24. -25. 10. 2005

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12. Viktor V. Kabanov, Jure Demšar, Dragan Mihailović: Kinetics of a superconductor excited with a femtosecond optical pulse. Phys. rev. lett., Vol. 95, pp. 147002-1-147002-4, 2005.
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29. Marko Žumer, Vincenc Nemanič, Bojan Zajec, Maja Remškar, Mihaela Ploscaru, Damjan Vengust, Aleš Mrzel, Dragan Mihailović: Field emission of point-electron source $Mo_6S_3I_6$ nanowires. Nanotechnology (Bristol), Vol. 16, pp. 1619-1622, 2005.
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1. Dragan Mihailović, Viktor V. Kabanov: Dynamic inhomogeneity, pairing and superconductivity in cuprates. Superconductivity in complex systems(Structure and bonding, 114), Karl Aleksander Müller, ed., A. Bussmann-Holder, ed., Berlin, Heidelberg, New York, Springer, 2005, pp. 331-364.

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### Regular Papers

1. Matija Avsec, Alenka Mertelj, Irena Drevenšek Olenik, Aleš Mrzel, Martin Čopič: Visco-elastic properties of nematic-MoS2 nanotubes mitures: [presented at 20th International Liquid Crystal Conference , Ljubljana, 2004]. Mol. cryst. liq. cryst. (Phila. Pa.: 2003), 435, pp. 163-172, 2005.
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3. Jure Demšar, Richard D. Averitt, A. J. Taylor, Viktor V. Kabanov: Cooper pair breaking dymanics in $MgB_2$ using optical-pump terahertz-probe spectroscopy. Ultrafast phenomena XIV: proceedings of the 14th International Conference, Niigata, Japan, July 25-30, 2004(Springer series in chemical physics, 79), Berlin, Heidelberg, New York, Springer, cop. 2005, 726-728.
4. Irena Drevenšek Olenik, Martin Čopič, M. E. Sousa, Suraj P. Gorkhali, Gregory Philip Crawford: Optical diffractiob properties of polymer dispersed liquid crystals switched by interdigitated electrodes: [presented at 20th International Liquid Crystal Conference , Ljubljana, 2004]. Mol. cryst. liq. cryst. (Phila. Pa.: 2003), 438, pp. 251-261, 2005.
5. Byungjo Jung, Bernard Choi, Boris Majaron, J. Stuart Nelson: Effects of lens housing temperature on subsurface temperature profiling using pulsed photothermal radiometry. Photonic therapeutics and diagnostics: 22-25 January 2005, San Jose, California, USA(Progress in biomedical optics and imaging, vol. 6)(Proceedings of SPIE, v. 5686), Bellingham, SPIE, cop. 2005, pp. 7-13.
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8. M. Rangus, Aleš Omerzu, Aleš Mrzel, Damjan Vengust, Dragan Mihailović: Magnetic properties of nanometer-sized particles of the superconductor $Mo_6S_6I_2$. Electronic properties of novel nanostructures: XIX International Winterschool/Euroconference on electronic properties of novel materials(AIP conference proceedings, 786), Melville, New York, American Institute of Physics, 2005, pp. 378-381.
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## THESES

### Ph. D. Thesis

1. Damjan Dvoršek: The influence of excitation conditions on the femtosecond relaxation dynamics in highly correlated systems : thesis = Vpliv pogojev vzbujanja na femtosekundno relaksacijsko dinamiko v močno koreliranih sistemih : doctoral dissertation, (Dragan Mihailović)

### M. Sc. Thesis

1. Aleš Mrzel: Analiza izvedbe projekta in organizacije "Center odličnosti nanoznanosti in nanotehnologije" na Institutu Jožef Stefan: magistrsko delo: Ljubljana, [A. Mrzel], 2005.

### B. Sc. Theses

1. Miha Mežnar: Photonic quasicrystals based on polymer-liquid crystal composites (Irena Drevenšek Olenik)
2. Matej Pregelj: Measurement of liquid crystal anchoring energy on weakly aligning polymer surface, (Martin Čopič, co-mentor Mojca Vilfan)
3. Dejan Škrabelj: One-dimensional spontaneuos aggregation of guanosine derivates (Irena Drevenšek Olenik)
4. Hana Uršič: Holographic gratings based on polymer-liquid crystal composites (Irena Drevenšek Olenik)

## PATENT APPLICATION

1. Vincenc Nemanic, Marko Žumer, Aleš Mrzel, Maja Remškar, Dragan D. Mihailovic
Use of quasi one dimensional transition metal ternary compounds and quasi one dimensional transition metal chalcogenide compounds as electron emitters
Patent application no. EP 03766800.1, US10/522,740, PCT/SI2003/00027, SI P-200200189

## INTERNATIONAL PROJECTS

1. Controlling Mesoscopic Phase Separation
COMEPHS
6. FP; NMP4-CT-2005-517039
Prof. E. Liarokapis, National Technical University of Athens, Zografou, Athens, Greece
Prof. Dragan Mihailović
2. Design, Synthesis and Growth of Nanotubes for Industrial Technology
DESYGN-IT
6. FP; NMP4-CT-2004-505626
Grace Dempsey, The Provost Fellows and Scholars of the College of the Holy and Undivided Trinity of Queen Elizabeth near Dublin, Dublin, Ireland
Prof. Dragan Mihailović
3. Template Grown Molecular Nanomaterials
NANOTEMP
5. FP; HPRN-CT-2002-00192
Dr. Karl S. Coleman, University of Oxford, Inorganic Chemistry Laboratory, Oxford, Great Britain
Prof. Dragan Mihailović
4. Ultrafast Processes in Low-Dimensional Nanomaterials
NATO Reintegration Grant
PDD (CD)-(EAP.RIG 981425)
Dr. F. Pedrazzini, NATO, Public Diplomacy Division, Collaborative Programmes Section,

Brussels, Belgium
Asst. Prof. Jure Demšar
5. Processes in Biophysical Matter Studied with Optical Tweezers
NATO Reintegration Grant
PDD (CD)-(EAP.RIG 981424)
Dr. F. Pedrazzini, NATO, Public Diplomacy Division, Collaborative Programmes Section, Brussels, Belgium
Dr. Mojca Vilfan
6. Holographic Recording in Photopolymerizable Liquid Crystalline Media
SI-AT/04-05/007
Asst. Prof. Martin Fally, Institut fuer Experimentalphysik, Vienna, Austria
Prof. Irena Drevenšek-Olenik
7. Dynamics of localized states in low dimensional systems – from picoseconds to hours
BI-HR/05-06-019
Dr. Damir Starešinić, Institut za fiziku, Zagreb, Croatia
Asst. Prof. Jure Demšar
8. Self-Assembling of Guanosine Derivates in Aqueous Solutions
BI-IT/02-05-023
Prof. Paolo Mariani, University at Ancona, Ancona, Italy
Prof. Irena Drevenšek Olenik
9. Surface Structure of Guanosine Derivatives on Solid Substrates
BI-IT/05-08-008
Prof. Paolo Mariani, Facoltŕ di Scienze, Universitŕ Politecnica delle Marche, Ancona, Italy
Prof. Irena Drevenšek Olenik
10. Study on Dynamics of Electron and Spin in New Molecular Nanostructures
BI-JP/03-04/3
Dr. Madoka Tokumoto, National Institute of Advanced Industrial Science and Technology (AIST), Nanotechnology Research Institute, Ibaraki, Japan
Prof. Dragan Mihailović
11. Inhomogeneous State and Conductivity of Complex Compounds
BI-RU/05-07-001
Dr. Rinat Mamin, E.K. Zavoisky Physical-Technical Institute, Kazan Scientific Center of Russian Academy of Science, Russia
Asst. Prof. Viktor Kabanov
12. Photoexcited Electron Dynamics in Heavy Electron Systems
BI-US/05-06-023
Dr. Antoinette J. Taylor, Center for Integrated Nanotechnology MST-CINT Mail Stop K756, Los Alamos National Laboratory, Los Alamos, USA
Asst. Prof. Jure Demšar
13. Development of Photothermal Technique for Characterization of Dermatologic Vascular Lesions
BI-US/05-06/022
J. Stuart Nelson, M. D. Ph. D., Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA, USA
Asst. Prof. Boris Majaron

# R & D GRANTS AND CONTRACTS

1. Biophysical processes studied with optical tweezers
Prof. Martin Čopič
2. Polymeric Nanocomposites
Boštjan Berčič
3. Development of novel laser therapies for dermatologic vascular lesions
Asst. Prof. Boris Majaron
4. Development of a system for anti armour guided missile laser signals detection
Asst. Prof. Igor Poberaj
5. Synthesis of 1D inorganic Nanostructures, Bionanostructures
Dr. Aleš Mrzel
6. Nanoelectronics and Nanotechnology Facilities
Prof. Dragan D. Mihailović

# RESEARCH PROGRAMS

1. Dynamics of Complex Systems
Prof. Dragan D. Mihailović
2. Light and Matter
Prof. Martin Čopič

# VISITORS FROM ABROAD

1. Prof. Dr. Wolfgang Lang, University of Vienna, Vienna, Austria, 12. - 13. 05. 2005.
2. Dr. Valentin Dediu, Instituto per lo Studio di Materiali Nanostrutturati – sezione Bologna, Consiglio Nazionale delle Ricerche, Bologna, Italy, 18. - 21. 05. 2005.
3. Dr. Mostafa Ellabban, Institut Department of Experimental Physics, University of Vienna, Vienna, Austria, 16. - 26. 5. 2005.
4. Dr. Steve Conradson, Los Alamos National Laboratory (LANL), USA, 31. 5. - 5. 6. 2005.
5. Dr. Alberto Riminucci, Istituto per lo Studio di Materiali Nanostrutturali – sezione di Bologna, Cosiglio Nazionale delle Ricerche, Bologna, Italy, 16. - 19. 06. 2005.
6. Dr. Takashi Kuzaya, Toyota Motor Corporation, Japan, 26. – 27. 05. 2005.
7. prof. Oliver Wright, Department of Applied Physics, Graduate School of Engineering, Hokkaido University, Sapporo, Japan, 23. - 25. 06. 2005.
8. Dr. Fabrice Dassenoy, LTDS, Ecole Centrale de Lyon, France, 24. – 25. 6. 2005.
9. Dr. Paolo Mariani, Universita' delle Marche, Ancona, Italy, 20. - 23. 9. 2005.
10. Prof. Dr. Martin Fally, Institute of Experimental Physics, University of Vienna, Vienna, Austria, 23. - 29. 10. 2005.

# STAFF

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6. Asst. Prof. Boris Majaron
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34. Mihaela Irina Ploscaru, B. Sc., Romania

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

# DEPARTMENT OF REACTOR PHYSICS F-8

***During the past year we have been working mainly on:***

- ***theoretical, experimental and applied reactor physics***
- ***plasma physics***
- ***ion fragmentation***
- ***neutron dosimetry***
- ***neutron radiography***
- ***physics of semiconductors***
- ***medicine (oncology - new methods for planning radiation treatment)***

Head:
***Prof. Bogdan Glumac***

Our research in **reactor physics** has been oriented mostly towards new methods for power and research reactor calculations, where special attention has been given to the calibration and benchmarking of nuclear data, and to computational methods. We have been working on problems connected with the decommissioning of research reactors, mainly in the area of biological shield activation. We continued with criticality safety calculations of the research reactor spent fuel pool, taking into account fuel burnup. We have focused attention on Monte Carlo neutron, photon and electron transport, and nuclear data processing for transport calculations, and on advanced nodal methods aimed at detailed power distribution reconstruction. The results of this basic research have been published in a number of papers, both in scientific journals and conference proceedings. We continued with the implementation and verification of our new two-dimensional program package for the TRIGA research reactor burn-up calculations. In 2005 we completed a demanding safety and sensitivity analysis of the different possibilities for long term storage of the NPP Krško spent fuel. Both wet and dry storage possibilities were studied. We have started work on an expert opinion connected with the introduction of the 'BEACON' core monitoring system. We have entered the field of new neutron sources in collaboration with the Institute for Transuranium Elements, where we study neutron production in ultra-fast pulsed laser interaction with matter. This year we initiated, in collaboration with the Nanostructure Materials Department, development and irradiation of SiC fibre based, low-activation, composite materials for the first wall of future fusion reactors. The activation of candidate materials was experimentally determined by irradiation in a reactor neutron beam followed by gamma spectroscopy. For better interpretation of the results, a calculation of the differences between the activation characteristics in fission and fusion neutron beams was performed.

*Figure 1: Prof. Heinrich Schwoerer, Kay-Uwe Amthor and Dr. Tomaž Žagar setting up fast proton and neutron detectors in protected target chamber of the multi-TW Ti:sapphire laser at the Jena University, Germany.*

In the area of **plasma physics** we continued the analysis, using a simple one dimensional fluid model, of the plasma potential formation in front of a negative electrode, which emits electrons and is immersed in a two electron temperature plasma. The model was considerably improved. By taking into account the electron repulsion in the pre-sheath potential drop we derived a modification of the Bohm criterion in the form of a transcendental equation for the Mach number. This equation can have up to three solutions, which correspond to three different Bohm velocities at the sheath edge. One solution is determined by the hot electron temperature, the second by the cool electron temperature, and the third is intermediate. The latter is a non-physical solution of the model. This result is in agreement with computer simulations and experiments reported in the literature where the formation of current-free double layers was observed in plasmas that contain energetic electron populations. Another consequence of the presence of hot electrons in the plasma is that the critical electron emission current may have a very pronounced minimum and maximum when regarded as a function of the electrode potential. This only occurs when the pre-sheath potential drop is determined by the cool electrons, as usually happens when the hot electron temperature is a bit elevated. Because of this the floating potential of the electrode may have up to 3 different values. Triple floating potentials of an electron emitting probe immersed in an energetic electron plasmas have been observed experimentally.

The work on **ion fragmentation** was continued by determination of fragmentation cross-sections of the radioactive isotopes of $^{9}C$ and $^{11}C$. These reactions are important in radiotherapy since the use of light radioactive ions promises the best results for future treatments. The research was carried out in collaboration with the Chalmers University of Technology, Goteborg, Sweden, and National Institute of Radiological Sciences, Chiba, Japan.

**Neutron radiography** and **neutron activation analysis** were used for the study of cultural heritage objects. Non-destructive examination and elemental analysis of excavated archaeological objects was performed in collaboration with the National Museum of Slovenia. Neutron radiography was also used for the study of the transport mechanisms of liquids in building materials, the emphasis being given to the study of moisture rise in concrete. This research was carried out in collaboration with the University of Maribor.

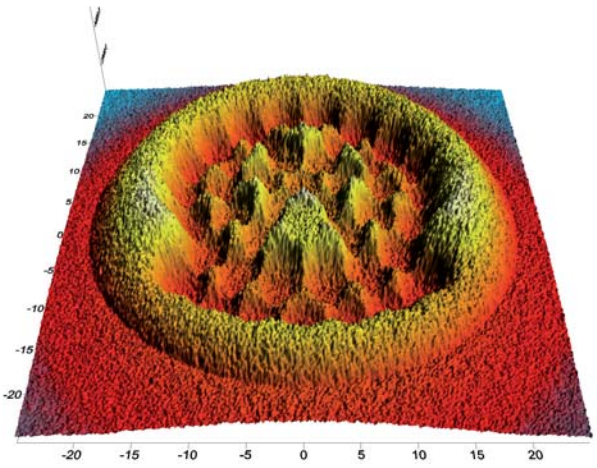


*Figure 2: Thermal flux distribution in the TRIGA reactor core calculated by MCNP Monte Carlo code.*

In the area of physics of semiconductor devices the potential use of organic semiconductors for particle and radiation detectors has been investigated. For this purpose organic monolayer Ag/PTCDA/ITO and Al/PuCu/ITO structures have been prepared by ionized cluster beam deposition and their room temperature electrical characteristics investigated. In order to interpret the results of the measurements the room temperature differential capacitance of monolayer metal/organic semiconductor/metal structures was derived. The derivation is based upon the following basic assumptions; a) the rectifying metal/organic semiconductor junction is characterized by the bias-dependent net excess charge density, induced at the interface, b) the postulated appropriate analytical expression of its bias voltage functional dependence, and c) the charge flow within the organic layer as represented by the space charge limited current, assuming the saturation of organic semiconductor charged traps. The predictions of the derivation were compared to the capacitance-voltage date of a number of measurements published in the literature within the last decade and, in all cases, good agreement with the predictions have been obtained. Assuming Fermi level alignment, it was shown that the transport bands of the structures investigated are well described in terms of a quadratic function of the coordinate as measured from the junction. The possibility of using a metal/organic semiconductor interface as a spin injector has also been investigated. Specifically, the role of a tunnelling barrier at a metal/organic semiconductor interface serving as a spin-selection mechanism has been considered. In this area, the ionized cluster beam experimental structure in which a thin interlayer is sandwiched between the metal and organic semiconductor doped with metal clusters, has been studied. The current spin polarization is found to critically depend on details of the disordered interlayer, the width and properties of which can, to some extent, be controlled in the ionized cluster.

In the field of **medicine (oncology – new methods for planning radiation treatment)** we studied the effect of statistical uncertainty on inverse treatment planning based on Monte Carlo method dose calculation.

Members of the department are also involved in the management of the **Research Unit of the Slovenian Fusion Association**. The latter was established in April 2005 when the Contract of Association between EURATOM and the Ministry of Higher Education, Science and Technology was signed. The Research Unit consists of two institutions: the Jožef Stefan Institute and the University of Ljubljana Faculty for Mechanical Engineering. In the year 2005, two meetings of the Steering Committee were prepared on which the research work-programmes and budgets for 2005 and 2006 were discussed and approved.

## Some outstanding publications in the year 2005

1. Maučec, M., Glumac, B., Criticality safety and sensitivity analyses of PWR spent nuclear fuel repository facilities. Nucl. technol., 2005, vol. 149, 2-13.
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## Organization of conferences, congresses and meetings

1. Organization and realization of the exhibition 'Fusion Expo – Energy for the Future' in the frame of 'Days of J. Stefan', Trg Revolucije 3, TR 3, Ljubljana, 21. 3. - 1. 4. 2005
2. Installation of the permanent exhibition »Fusion – Energy for the future« at the 'Milan Čopič Nuclear Training Centre', JSI, 1. 12. 2005

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2. Bruno Cvikl, Dean Korošak, Matjaž Koželj: C-U investigation for fermi level alignment at metal/organic semiconductor junction. Proceedings, 41th International Conference on Microelectronics, Devices and Materials and the Workshop on Green electronics, September, 14. - September 16. 2005, Ribno, Slovenia, Barbara Malič, ed., Darko Belavič, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2005, pp. 333-338.
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27. Luka Snoj, Matjaž Ravnik: Effect of fuel particles' size variations on multiplication factor in pebble-bed nuclear reactor. Proceedings, International Conference Nuclear Energy for New Europe 2005, September 5-8, 2005, Bled, Slovenia, Borut Mavko, ed., Ivo Kljenak, ed., Ljubljana, Nuclear Society of Slovenia 2005.
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# THESES

## B. Sc. Theses

1. Tomazin Milan: Criticality Analysis of Homogeneous Mixtures of Uranium and Plutonium (Matjaž Ravnik)
2. Snoj Luka: Effect of Packing Fraction Variations on Multiplication Factor in Pebble-Bed Nuclear Reactor (Matjaž Ravnik)
3. Jure Maglica: Hydrogen plasma production and diagnostics (Milan Čerček, co-mentor Tomaž Gyergek)
4. Zupanič Jože: Influence of Density on Mechanical Properties of High Density PM Steel (Radomir Ilić)

# INTERNATIONAL PROJECTS

1. RU Administration and Services
   EURATOM – MHST
   6. FP, Slovenian fusion assotiation– EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministrstvo za visoko šolstvo, znanost in tehnologijo, Ljubljana, Slovenia
   Prof. Milan Čerček
2. Nuclear Data: Benchmark Experiments to Validate EFF/EAF Data TW5-TTMN-002
   EURATOM – MHST
   6. FP, Slovenian fusion assotiation– EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministrstvo za visoko šolstvo, znanost in tehnologijo, Ljubljana, Slovenia
   Dr. Igor Lengar
3. Collaboration in DEMO Working Group
   EURATOM – MHST
   6. FP,Slovenian fusion assotiation– EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministrstvo za visoko šolstvo, znanost in tehnologijo, Ljubljana, Slovenia
   Prof. Matjaž Ravnik
4. Interaction of Vibrationally Excited Hydrogen with Fusion Relevant Materials
   EURATOM – MHST
   6. FP, Slovenian fusion association– EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministrstvo za visoko šolstvo, znanost in tehnologijo, Ljubljana, Slovenia
   Prof. Milan Čerček, Dr. Iztok Čadež
5. Interaction of Vibrationally Excited Hydrogen with Fusion Relevant Materials
   VEVOF
   6. FP, EURATOM; FU06-CT-2003-00010
   EC; European Commission, DG Research - J.6, Brussels, Belgium
   Prof. Milan Čerček, Dr. Iztok Čadež
6. Experimental Investigations of the Formation of Nonlinear Potential Structures in bounded Plasmas and their Diagnostics
   SI-AT/04-05/009
   Prof. Roman Schrittwieser, Institute for Ion Physics, University of Innsbruck, Innsbruck, Austria
   Prof. Milan Čerček
7. Transport Processes of Light and Heavy Ions in Matter and their Application in Medicine, Intercontinental and Space Flights and Nuclear Waste
   Alexander Golovchenko, Joint Institute for Nuclear Research, Dubna, Moscow Region, Russia
   Dr. Marko Giacomelli
8. The Use of Nuclear Methods in Geophysical Investigations in Different Regions of Earth
   BI-UA/05-06-005
   Dr. Volodymyr Pyvlovych, Institute for Nuclear Research, Kyiv, Ukraine
   Prof. Radomir Ilić

# R & D GRANTS AND CONTRACTS

1. High energy ion interactions in tissue-like materials and metals
   Prof. Radomir Ilić
2. Interfacial amorphization and Fermi level pinning
   Prof. Bruno Cvikl
3. Investigation of fusion relevant phenomena in plasma-wall interaction
   Prof. Milan Čerček
4. Radiation field characterization for diagnostic and therapeutic use of radioactive isotopes
   Asst. Prof. Robert Jeraj
5. Fusion relevant research of plasma interaction with surfaces
   Prof. Milan Čerček
6. Long-lived activation in fission and fusion reactor shields
   Prof. Bogdan Glumac, dr. Tomaž Žagar
7. Climate changes and national security in Slovenia
   Prof. Matjaž Ravnik

# RESEARCH PROGRAM

1. Reactor Physics
   Prof. Bogdan Glumac

# NEW CONTRACTS

1. Contract of Association EURATOM - MHST, Slovenian Fusion Association
   Ministrstvo za visoko šolstvo, znanost in tehnologijo
   Prof. Milan Čerček
2. Promotion of Science: Fusion Expo 2005
   Ministrstvo za visoko šolstvo,znanost in tehnologijo
   Prof. Milan Čerček
3. Sensitivity Analysis of Nuclear Core Parameters due to the NPP Krško Modernization
   Ministrstvo za okolje in prostor
   Dr. Marjan Kromar

# VISITORS FROM ABROAD

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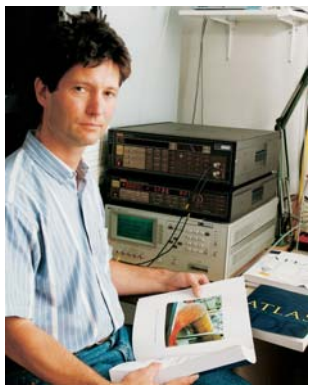
# DEPARTMENT OF EXPERIMENTAL PARTICLE PHYSICS F-9

***Departmental research is devoted to experimental studies of elementary particles, 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, at DESY in Hamburg, at KEK in Tsukuba and LNGS in Italy. The department is also engaged in developing and applying the technologically advanced particle detector, that is demanded by such measurements. Astro-particle physics is an emerging field applying the experimental techniques of particle physics to solve astrophysical problems. Slovenian researchers are participating in the construction of the Pierre Auger observatory and in the first measurements of ultra-high-energy cosmic rays with the apparatus spread over 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), under construction 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, the German centre DESY in Hamburg, the Japanese centre KEK in Tsukuba and the Italian centre Laboratori Nazionali di Gran Sasso (LNGS). We are taking part in five experiments, each conducted as an international collaboration:

- ATLAS at the Large Hadron Collider (LHC) at CERN (1900 researchers, 150 institutions),
- Belle at the asymmetric electron-positron collider (KEK-B) at KEK (400 researchers, 56 institutions)
- DELPHI at the Large Electron Positron collider (LEP) at CERN (520 researchers, 52 institutions) and
- HERA-B at the HERA electron-proton collider at DESY (310 researchers, 33 institutions)
- ICARUS at the CNGS neutrino beam in Laboratori Nazionali di Gran Sasso (94 researchers, 20 institutions)

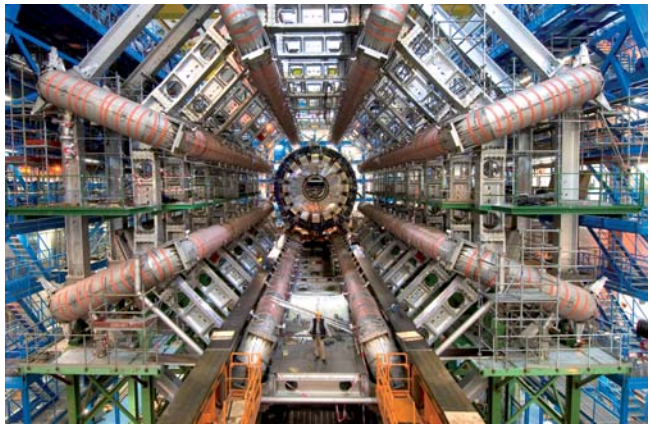


*Figure 1: View into the heart of the ATLAS detector in the experimental cavern 160 m underground right after the installation of the final, eighth, coil of the central toroid.*

In the field of astroparticle physics we are part of the Pierre Auger collaboration (200 researchers, 55 institutions), which is constructing 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 Nova Gorica Polytechnic.

A detailed report on the 2005 activities follows, focused on the contributions of our researchers:

## ATLAS

- Intensive installation of huge detector parts is taking place in the experimental cavern 160 m underground aiming to have the complete detector operational for first LHC collisions in spring 2007.
- Production of over 4000 modules of the SCT tracker has been finished and their integration on barrels and end-cap disks is well advanced.
- Detector modules with diamond sensors for the beam conditions monitoring system were tested.
- Radiation monitor was developed and the first modules produced and installed.
- New batch of flexible printed circuits with dimensions up to 3.5 m on copper-Kapton laminates were produced serving as power tapes for the SCT end-caps.

- Generation of phase-space in proton collisions at 14 TeV was studied.
- Background to Higgs boson searches in the Standard Model and MSSM was simulated in detail.
- Simulation of top quark production in proton-proton collisions was studied and a simulation programme written.
- Grid infrastructure on the SiGNET computer cluster had been constantly upgraded and large amounts of simulated data were produced as part of "ATLAS Data Challenge 2".

**BELLE**

- Precision measurements of CP violation processes in the B meson system involving Penguin diagrams were improved considerably.
- Measurement of the $V_{ub}$ CKM matrix element was improved.

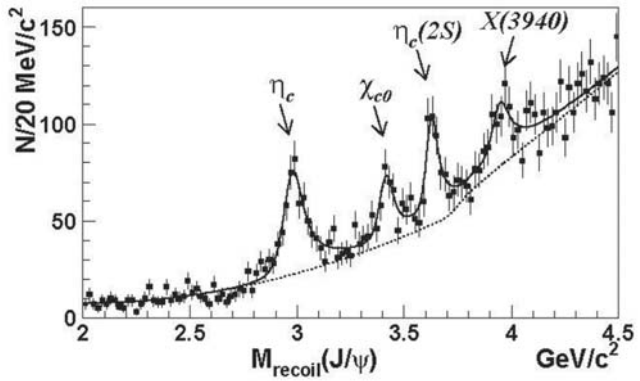



*Figure 2: Distribution of masses recoiling against reconstructed J/Ψ in inclusive $e^+e^- \rightarrow J/\Psi X$ events. The peak centred at 3.940 GeV/$c^2$ corresponds to the new state X(3940).*

- We took over the responsibility of convening the charm quark studies group.
- Best limits were obtained for $D^0$ mixing parameters in semileptonic and hadronic decay channels
- New charmed baryon $\Sigma_c(2800)$ and a new, possibly charmonium, state X(3940) were discovered.
- Experimental evidence for the existence of the $\Theta(1540)^+$ pentaquark was refuted by our data.
- Charm quark fragmentation measurement was considerably improved.
- First measurement of $B \rightarrow D_{sj} K$ decays was performed.
- Measurement of CP violation in the $B \rightarrow DD$ decay was initiated.
- Commissioning of the semiconductor tracker was performed using measured tracks.
- New type of Cherenkov counter based on an aerogel radiator was developed and tested in the beam.

*Figure 3: LIDAR station in the Argentinean pampas near Malargue. Our hardware contribution to the Pierre Auger detector uses scattered light from lasers to monitor atmospheric conditions, paramount for proper evaluation of the fluorescence detector data.*

**DELPHI**

- Final analyses were performed and prepared for publication.

**HERA-B**

- Cross-sections for production of hyperons, and D and J/Ψ mesons were measured.

**ICARUS**

- Detector simulations were preformed and data analysis programmes prepared.

**PIERRE AUGER**

- Third fluorescence detector at Los Morados site was put into operation and construction of the fourth at Loma Amarilla started.
- Second and third Lidar stations were installed at Coihueco and Los Morados sites.
- Continuous installation of ground detectors, now covering 70% of the planned surface, was taking place
- More than ten cosmic rays with energies in excess of $10^{19}$ eV were detected.
- Arrival direction anisotropy of cosmic rays was studied.

**Detector development**

- In collaboration with CERN, University of Valencia and University of Michigan, Ann Arbor a pre-clinical prototype of the Compton camera was assembled and tested.

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1. Matevž Tadel: Gled - an implementation of a hiearchic server-client model. Applied parallel and distributed computing(Advances in computation: theory and practice, v. 16), Yi Pan, ed., Laurence Tianruo Yang, ed., New York, Nova Science Publishers, cop. 2005, pp. 21-36.

# PUBLISHED CONFERENCE PAPERS

## Invited Paper

1. Boštjan Golob: New resonances at Belle: presented at the Cracow Conference on Hadron Spectroscopy, January, 6-8,2005, Cracow, Poland. Acta Phys. Pol., B, Vol. 36, pp. 2301-2314, 2005.

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1. I. Adachi, et al. (22 authors): Development of new silica aerogel for the RICH radiator of the super Belle detector. 2004 IEEE Nuclear Science Symposium Conference Record, 16-22 October 2004, Rome Italy, Piscataway, IEEE, 2005, 3 pp.
2. Andrej Gorišek, Igor Mandić, Samo Korpar, Marko Zavrtanik, Y. Musienko, Peter Križan: Uniformity of the APD response after irradiation. 2004 IEEE Nuclear Science Symposium Conference Record, 16-22 October 2004, Rome Italy, Piscataway, IEEE, 2005, 3 pp.
3. Samo Korpar, et al. (22 authors): Tests of the BURLE 85011 micro-chanell plate PMT as the detector of Cherenkov photons. 2004 IEEE Nuclear Science Symposium Conference Record, 16-22 October 2004, Rome Italy, Piscataway, IEEE, 2005, 4 pp.
4. Belle SVD group: H. Kurashiro, et al. (100 authors): Level-1 silicon vertex detector trigger at Belle. 2004 IEEE Nuclear Science Symposium Conference Record, 16-22 October 2004, Rome Italy, Piscataway, IEEE, 2005, 5 pp.
5. G. Llosá, et al. (20 authors): Development of a pre-clinical compton probe prototype for prostate imaging. 2004 IEEE Nuclear Science Symposium Conference Record, 16-22 October 2004, Rome Italy, Piscataway, IEEE, 2005, 4 pp.
6. Shohei Nishida, et al. (21 authors): Studies of a proximity focusing aerogel RICH for the Belle upgrade. 2004 IEEE Nuclear Science Symposium Conference Record, 16-22 October 2004, Rome Italy, Piscataway, IEEE, 2005, 5 pp.
7. Rok Pestotnik, Samo Korpar, Peter Križan, Aleš Stanovnik: Detection of $^{90}$Sr with aerogel Cherenkov detector with low background. 2004 IEEE Nuclear Science Symposium Conference Record, 16-22 October 2004, Rome Italy, Piscataway, IEEE, 2005, 3 pp.
8. The Belle SVD group: R. Stamen, et al. (97 authors): The Belle L1.5 trigger. 2004 IEEE Nuclear Science Symposium Conference Record, 16-22 October 2004, Rome Italy, Piscataway, IEEE, 2005, 5 pp.
9. Špela Stres, Rok Pestotnik: Possibility for spin flip in high energy electron rings. 2004 IEEE Nuclear Science Symposium Conference Record, 16-22 October 2004, Rome Italy, Piscataway, IEEE, 2005, 5 pp.
10. Belle SVD group: T. Ziegler, et al. (97 authors): The improved ladder production for the Belle silicon vertex detector (SVD2.1). 2004 IEEE Nuclear Science Symposium Conference Record, 16-22 October 2004, Rome Italy, Piscataway, IEEE, 2005, 5 pp.
11. Tomi Živko: Search for pentaquarks in proton-nucleus collisions at $\sqrt{s}$=41.6 GeV. Few-body problems in physics: the 19th European Conference on Few-Body Problems in Physics, Groningen, the Netherlands, 23-27 August, 2004(AIP conference proceedings, vol. 768), Nasser Kalantar-Nayestanaki, ed., Rob G.E. Timmermans, ed., Bernard L.G. Bakker, ed., Melville, American Institute of Physics, 2005, pp. 232-234.

# THESES

## Ph. D. Theses

1. Andrej Studen: Compton Camera with Position-Sensitive Silicon Detectors (Supervisor: Marko Mikuž)
2. Ilija Bizjak: Measurement of $|V_{ub}|$ Using Inclusive Semileptonic Decays on a Sample of Reconstructed B Mesons with the Belle Detector (Supervisor: Peter Križan)

# INTERNATIONAL PROJECTS

1. Enabling Grids for E-sciencE
   EGEE; 6. FP; 508833
   EC; Prof. Fabrizio Galliardi, CERN, Geneve, Switzerland
   Prof. Marko Mikuž
2. Safe Production and Use of Nanomaterials
   NANOSAFE2; 6. FP; NMP2-CT-2005-515843
   EC; Commissariat a l'Energie Atomique, Grenoble, France
   Andrej Detela, Asst. Prof. Maja Remškar, Marko Žumer, Asst. Prof. Boris Turk
3. Collaboration DELPHI
   Dr. Jan Timmermans, CERN, Geneve, Switzerland
   Asst. Prof. Borut Paul Kerševan
4. Collaboration HERA-B
   Dr. Mike Medinnis, Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany
   Prof. Peter Križan
5. Collaboration ATLAS
   Prof. Peter Jenni, CERN, Geneve, Switzerland
   Prof. Marko Mikuž
6. Collaboration CERN RD-39
   Dr. Jaako Haarkonen, HIP, Finland
   Dr. Zheng Li, BNL, USA
   Prof. Marko Mikuž
7. Collaboration CERN RD-50
   Prof. Mara Bruzzi, University of Florence, Florence, Italy
   Dr. Michael Moll, CERN, Geneve, Switzerland
   Prof. Marko Mikuž
8. Collaboration Belle
   Prof. Masanori Yamauchi, KEK, Tsukuba, Japan
   Prof. Peter Križan
9. Collaboration ICARUS
   Prof. Carlo Rubbia, Universitŕ di Pavia, Italy
   Asst. Prof. Tomaž Podobnik
10. Collaboration CIMA
    Cameras for Imaging in Medical Applications
    Prof. Peter Weilhammer, CERN, Geneve, Switzerland
    Prof. Marko Mikuž
11. Study of Top Events produced at the LHC for the Commissioning of the ATLAS Detector
    Dr. Marina Cobal, Universitŕ di Udine, Udine, Italy
    Asst. Prof. Borut Paul Kerševan
12. New Methods for Measurements of D Meson Mixing
    Prof. Fumihiko Takasaki, KEK, Institute of Particle and Nuclear Studies, Ibaraki-ken, Japan
    Asst. Prof. Marko Starič
13. Development of Readout System for the Belle Proximity Focusing Ring Imaging Cherenkov Detector
    SLO-JPN
    Prof. Fumihiko Takasaki, KEK, Institute of Particle and Nuclear Studies, Ibaraki-ken, Japan
    Dr. Rok Pestotnik

# R & D GRANTS AND CONTRACTS

1. Measurements of Rare Decays of B and D Mesons
   Asst. Prof. Samo Korpar
2. Search for Exotic Hadronic Bound States
   Asst. Prof. Tomi Živko
3. Data Analysis Tools and Environment for Physics Research with the ATLAS detector
   Asst. Prof. Borut Paul Kerševan
4. Structures and Materials for Advanced Radiation Hard Detectors
   Asst. Prof. Marko Zavrtanik
5. Semiconductor Detectors for Medical and High Radiation Fields Applications
   Dr. Dejan Žontar
6. Novel Direct Electric Drives
   Andrej Detela, B. Sc.
7. SigNET - Development and Implementation of Grid Technologies with the European Project EGEE Including the Transfer into the Slovenian Environment
   Prof. Marko Mikuž
8. National Support of the EGEE Project, EU-Grid Integration and Development of Grid Framework for HEP Applications
   Prof. Marko Mikuž
9. NIDAR - Optical Laser System for 3D Scanning
   Asst. Prof. Marko Zavrtanik

# RESEARCH PROGRAMS

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

# NEW CONTRACT

1. Development of inovative technologies
   Elgo-line, d. o. o., Cerknica
   Prof. Vladimir Cindro

# VISITORS FROM ABROAD

1. Takayuki Seki, KEK, Tsukuba, Japan, 12. 2.–7. 3. 2005
2. Prof. Dr. Walter Schmidt-Parzefall, Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany, 9.–12. 4. 2005
3. Prof. Dr. Louis Lyons, University of Oxford, Oxford, Great Britain, 4.–10. 5. 2005
4. Dr. Mark Tobin, University of Liverpool, Liverpool, Great Britain, 13. 5. 2005
5. Dr. Cigdem Issever, University of Oxford, Oxford, Great Britain, 6.–7. 6. 2005
6. Jacob Oliver Stack, Imperial College, London, Great Britain, 4. 7.–12. 8. 2005
7. Dr. Ulrich Parzefall, Dr. Jens Meinhardt, Albert-Ludwigs-Universität Freiburg, Fakultät für Physik, Freiburg, Germany, 9.–11. 6. 2005
8. Dr. Beniamino di Girolamo, CERN, Geneva, Switzerland, 9.–11. 6. 2005
9. Prof. Dr. W. Leslie Rogers, Department of Biomedical Engineering and Internal Medicine, University of Michigan, Ann Arbor, USA, 9.–13. 7. 2005
10. Dr. Cigdem Issever, Dr. Todd Huffman, University of Oxford, Oxford, Great Britain, 8.–12. 8. 2005
11. Prof. Dr. Toru Iijima, University of Nagoya, Nagoya, Japan, 15.–18. 10. 2005
12. Federico Ravotti, Maurice Glaser, CERN, Geneva, Switzerland, 21.–25. 11. 2005

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7. Prof. Peter Križan*
8 Asst. Prof. Igor Mandić**
**9. Prof. Marko Mikuž*, Head**
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11. Prof. Aleš Stanovnik*
12. Asst. Prof. Marko Starič**
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30. Jure Eržen
31. Majda Kelbelj
32. Erik Margan

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

# DEPARTMENT OF INORGANIC CHEMISTRY AND TECHNOLOGY K-1

***The Department of Inorganic Chemistry and Technology is one of the leading groups in the world in the field of the synthesis of new inorganic compounds containing fluorine. The main research fields are: reactions in superacids, the chemistry of noble gases, the chemistry of the elements of 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 the technological and ecological problems in Slovenia. The group has now been closely cooperating with Slovenian industry for more than thirty years. Finally, it is worth mentioning that the group is active in the education of chemistry teachers and in the promotion of natural sciences among college and elementary school students.***

Head:
***Prof. Boris Žemva***

In the research of new inorganic compounds containing fluorine, new coordination compounds of the type $[M^{x+}(L)_n](AF_6)_x$ (M is metal, e.g. Mg, Ca, Sr, Ba, Cd or a lanthanide element; A is P, As, Sb, B; L is ligand, e.g. $XeF_2$, $AsF_3$, HF, and x is the oxidation number of the central metal atom) have been synthesized. In the year 2005 research in this area was focused on the coordination compounds with anions $PF_6^-$, $TaF_6^-$ and $RuF_6^-$. The following crystal structures were determined: $[Ba(XeF_2)_4](PF_6)_2$, $[M(XeF_2)_3](PF_6)_2$ (M = Sr, Pb), $[Ba(XeF_2)_5](AsF_6)_2$, $[Cd(AsF_3)_2](AsF_6)_2$, $Cd_2(XeF_2)_6(SbF_6)_4$, $LiTaF_6$, $Ba(H_3F_4)_2$, $La(BF_4)_3$, and $Xe_2F_3RuF_6$. In the course of the study of the formation of oxonium salts in superacid media, single crystals of $H_3OCdSbF_6(Sb_2F_{11})_2$, $(H_3O)_3Cd(SbF_6)_5$, $(H_3O)_2Cd_2F(SbF_6)_5$ and $H_3O[Cd(HF)]_4(SbF_6)_9$ were obtained in the $CdF_2$/CdO-$SbF_5$-HF system, and their crystal structures determined. Additionally, single crystals of $(H_3O)_2La(BF_4)_5$ were prepared in the $La_2O_3$-$BF_3$-HF system and their crystal structure determined.

## Synthesis and structure of the first example of a homoleptic HF metal environment

Investigations of the binary fluoride /Lewis acid ($AsF_5$, $SbF_5$, $BF_3$, etc.) systems were continued. Compounds with the general formula $InPnF_6$ (Pn = P, As, Sb) were synthesized. The structural type of these compounds was determined from X-ray powder diffraction data and with the help of vibrational spectroscopy. Besides $InBF_4$ these are the only examples of $In^I$ compounds in a pure fluorine environment. The crystal structure of $La(BF_4)_3$ was determined. In co-operation with the University of Moscow we also investigated the gaseous products of the thermal decomposition of Ni(IV), Tb(IV), Mn(IV) and Pt(IV) ternary fluorides.

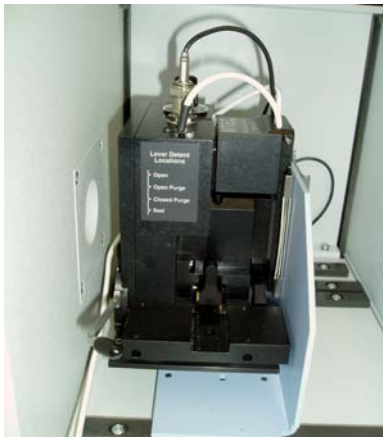

Figure 1: Photo-acoustic IR cell

Large quantities of $AgBF_4$ and $LiBF_4$ are used in several industrial applications, the former compound as a catalyst and the latter in the production of primary and secondary lithium batteries. The crystal structures of both compounds were unknown due to the preferential formation of twinned crystals. In spite of this, we have succeeded in determining their crystal structures, which contributes to a better understanding of the physical properties of $MBF_4$ (M = Ag, Li) salts. The work on $LiBF_4$ was carried out in cooperation with the University of Kyoto, Japan.

Together with researchers from Colorado State University, USA, and Moscow State University, Russia we have continued the study of selective fluorination of fullerenes.

With the Aichi Institute of Technology, Nagoya, Japan, we studied fluorination of petroleum cokes and fluorinated natural graphite powder with different fluorinating agents ($ClF_3$, $NF_3$) in the 200 °C - 500 °C temperature range.

In the framework of the COST 527 'Plasma Polymers and Related Materials' project new hydrophobic polymer films were prepared by plasma polymerisation of $SF_6$ gases and aliphatic fluorocarbons. Changes in the wetability of cotton and wool fabrics was achieved by modification of the fabric surface by polymer films deposited in a plasma of $SF_6$ or $CF_3SF_5$ gases with benzene or fluorobenzene.

In 2005 the research carried out within the European project FUNFLUOS was focused on the preparation of aluminium fluoride with a high surface area, HS-$AlF_3$. Oxidative decomposition of

*Figure 2: Reaction vessel (700 ml) for the preparation of $AlF_3$ with high surface area in liquid anhydrous HF*

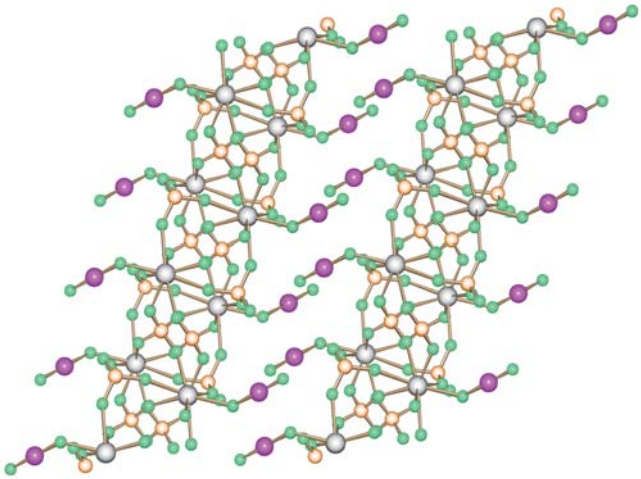

*Figure 3: Layers in the structure of $[Cd(XeF_2)](BF_4)_2$*

hydrazinium(2+) fluoroaluminate, $N_2H_6AlF_5$, with elemental fluorine was investigated as a possible alternative to the recently developed sol-gel routes to metal fluorides. The heterogeneous gas-solid reaction between $N_2H_6AlF_5$ and $F_2$ was difficult to control. Achieving repeatability of the preparation was the main problem. The product was partially crystallised $AlF_3$ with a relatively low surface area (25 $m^2g^{-1}$). When the reaction was carried out in a liquid anhydrous hydrogen fluoride (aHF) medium the product was amorphous $AlF_3$ with unusually high surface area (200-300 $m^2g^{-1}$), high Lewis acidity, and high catalytic activity in isomerisation of $CClF_2CCl_2F$ to $CCl_3CF_3$. This reaction is known to proceed only in the presence of the strongest Lewis acids, such as $SbF_5$. Preparation in the liquid aHF medium could be safely scaled-up to 10 g of HS-$AlF_3$ per batch with good repeatability. In similar reactions of chromium precursors, chromium oxofluorides were formed with surface areas of 200 $m^2g^{-1}$. In comparison with sol-gel routes, the oxidative decomposition to HS fluorides proceeds in one step and yields materials with no organic residue.

The modelling method developed using artificial neural networks on empirical data was successfully applied to the problem of the PCB polluted Krupa river.

A computer program is under development for computation of fluid dynamics in a flue gas scrubber useful for the dimensional and efficiency optimization of the scrubber.

**Preparation of larger amounts of $AlF_3$ with surface areas of 200-300 $m^2/g$. This $AlF_3$ is an excellent acid catalyst.**

Work within the scope of the EU 5th FP programme project "Accidental Risk Assessment Methodology for Industries - ARAMIS" (http://aramis.jrc.it) on a new harmonized method for risk assessment in the context of the Seveso II directive was finalized. We were engaged in the testing of the methodology at a selected Slovenian industrial establishment as well as in the documenting and dissemination of the methodology.

Within the EU 6th FP CA SHAPE RISK (http://shaperisk.jrc.it) project, involving 22 partners, we were engaged in three work packages: Survey and comparison of the tools, methods and service platforms for risk management within EU countries; Improving the efficiency of the organisational management with regard to safety, health, and environment; and public perception and communication on risk. Results of the project were and will be presented to the relevant scientific, technical and policy-making audiences. The results will also be used in the preparation of the 7th FP priorities and for revision and implementation of directives 96/82/EC (Seveso II), 96/61/EC (IPPC), and 89/391/EEC (Atex).

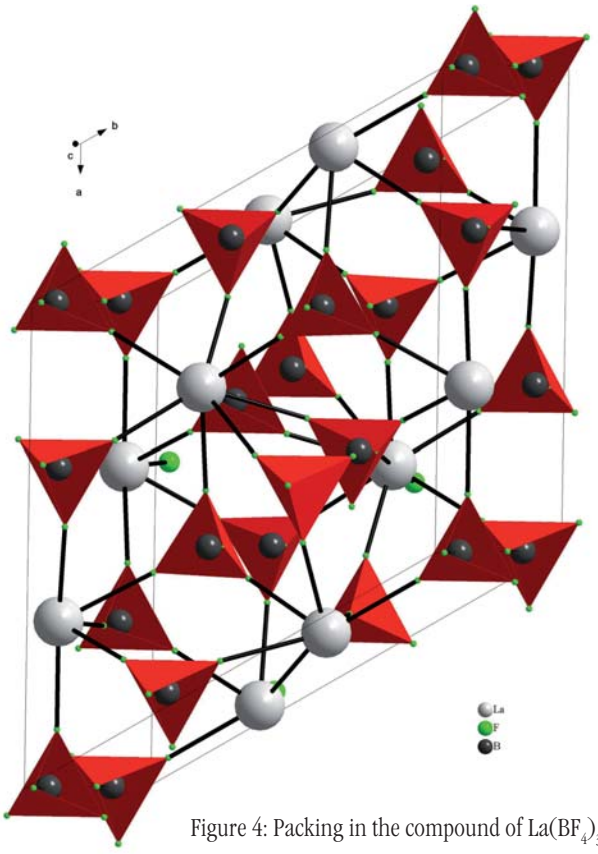


Figure 4: Packing in the compound of $La(BF_4)_3$

In the frame of development research organised by the Slovenian environmental cluster, led by Esotech, we have been cooperating in three projects: Development of thermal treatment of wastes in fluidized beds, acting as a catalyst and/or reagent; Continuation of the development of low cost FGD; Development of additives for the enhancement of the wet calcite FGD process efficiency. With the project "Thermal use of waste" we were engaged in the work of the Centre of Excellence Environmental technologies -CEET (led by IJS). CEET was involved in the establishment of the Slovenian technological platform for water. In the FP6 project Biomercury we have been involved in the preparation of the first interim report for work package (WP) 'Mercury in oil and gas'.

In the analytical laboratory a method for the determination of total fluoride in soil was validated. Total decomposition of samples was achieved with pyrohydrolysis using $WO_3$ as an accelerator. The amount of fluoride in decomposed samples was determined using a fluoride ion-selective electrode. A method for decomposition and the determination of total fluoride in food and organic matter was developed. Total decomposition was achieved by fusion with $KNaCO_3$. The methods developed were used for the determination of possible contamination with gaseous fluorides in the surroundings of the aluminium production facility Talum Kidričevo.

Activities in the field of education and promotion of science among the young were a part of projects financed by the Ministry of Education, Science and Sport, and Ministry of Higher Education, Science and Technology. In

the school year 2004/2005 thirty-six one-week courses for college students and elementary schools pupils were organised in our laboratory. For chemistry teachers a special seminar was organised to present them with experiments which could be shown during lessons.

## Some outstanding publications in the year 2005

1. G. Tavčar, B. Žemva, $XeF_2$ as a ligand in a coordination compound with the $BF_4^-$ anion, Inorg. chem., 44 (2005), 1525-1529
2. M. Tramšek, G. Tavčar, T. Bunič, P. Benkič, B. Žemva, Alkaline earth metal poly(hydrogen fluorides) hexafluoroarsenates(V) and hexafluorophosphate(V) : $M_2(H_2F_3)(HF_2)_2(AF_6)$ (M=Ca, A=As; M=Sr, A=As,P). J. Fluorine Chem., 126 (2005), 1088-1094
3. Z. Mazej, Indium(I) hexafluoropnictates ($InPnF_6$; Pn =P, As, Sb), European Journal of Inorganic Chemistry, (2005), 3983-3987
4. M. Ponikvar, J. Šnajder, B. Sedej, Honey as a bioindicator for environmental pollution with $SO_2$, Apidologie, 36 (2005), 403-409
5. G. B. Deacon, D. J. Evans, P.C. Junk, E. Lork, R. Mews, B. Žemva, Stabilising small cluster: synthesis and characterisation of thermolabile $[Gd_4F_7(15\text{-crown-}5)_4][AsF_6]_5 \cdot 6SO_2$, Dalton Trans. (2005), 2237-2238.

*Figure 5: Participants of Slovenian-Japanese meeting in Ljubljana, September, 2005*

## Organization of conferences, congresses and meetings

1. First regular meeting of the FUNFLUOS consortium (EU project), Ljubljana, April 21-24, 2005
2. Slovenian - Japanese joint seminar: Syntheses, structures and applications of advanced inorganic fluorides, Ljubljana, September 12-16, 2005

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2. M. S. Leskiv, S. V. Abramov, L. I. Oleinik, A. V. Kepman, V. F. Sukhoverkhov, Zoran Mazej, D. V. Rau, N. S. Chilingarov, Lev Nikolaevich Sidorov: Vaporization products of transition-metal and rare-earth complex fluorides studied by high-temperature mass spectroscopy. Inorg. mater., Vol. 41, pp. 1327-1333, 2005.
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6. Aleš Mrzel, Janez Kovač, Maja Remškar, Adolf Jesih, Dragan Mihailović: New $Mo_6S_{3-x}Se_xI_6$ (x=0.05) nanowires. Synth. met., Vol. 153, pp. 309-312, 2005.
7. Maja Ponikvar, Joel F. Liebman: Paradoxes and paradigms: When do alkali metal (Na) and alkaline earth (Mg, Ca) halides (F, Cl) completely dissociate? A combined analytical and thermochemical approach. Struct. chem., Vol. 16, pp. 587-591, 2005.
8. Maja Ponikvar, Jože Šnajder, Borislava Sedej: Honey as a bioindicator for environmental pollution with ($SO_2$)[1]. Apidologie, Vol. 36, pp. 403-409, 2005.
9. Maja Remškar, Aleš Mrzel, Adolf Jesih, Janez Kovač: New composite $MoS_2$-$C_{60}$ crystals. Adv. mater. (Weinh.), Vol. 17, pp. 911-914, 2005.
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11. Melita Tramšek, Gašper Tavčar, Tina Bunič, Primož Benkič, Boris Žemva: Alkaline earth metal poly(hydrogen fluorides) hexafluoroarsenates(V) and hexafluorophosphate(V): $M_2(H_2F_3)(HF_2)_2(AF_6)$ (M=Ca, A=As; M=Sr, A=As,P). J. fluorine chem., Vol. 126, pp. 1088-1094, 2005.
12. Polona Umek, Pavel Cevc, Adolf Jesih, Alexandre Gloter, Christopher Paul Ewels, Denis Arčon: Impact of structure and morphology on gas adsorption of titanate-based nanotubes and nanoribbons. Chem. mater., Vol. 17, pp. 5945-5950, 2005.
13. Glen B. Deacon, David J. Evans, P. C. Junk, E. Lork, Rüdiger Mews, Boris Žemva: Stabilising small cluster: synthesis and characterisation of thermolabile $[Gd_4F_7(15\text{-crown-}5)_4][AsF_6]_5 \cdot 6SO_2$. Dalton trans. (2003. Print), pp. 2237-2238, 2005.
14. Angel García-Raso, Juan J. Fiol, Andrés Tasada, María J. Prieto, Virtudes Moreno, Ignasi Mata, Elies Molins, Tina Bunič, Amalija Golobič, Iztok Turel: Ruthenium complexes with purine derivatives: syntheses, structural characterization and preliminary studies with plasmidic DNA. Inorg. chem. commun., Vol. 8, no. 9, pp. 800-804, 2005.
15. Zoran Mazej, Boris Žemva: Synthesis of arsenic pentafluoride by static fluorination of $As_2O_3$ in a closed system. J. fluorine chem., Vol. 126, pp. 1432-1434, 2005.


## PUBLISHED CONFERENCE PAPERS

### Invited Papers


1. Milena Horvat, Andrej Stergaršek: Activities of the Centre of Excellence for environmental technologies (CEET) and its opportunities in environmental pollution case study in China and Slovenia. The economic impact of environment protection, Environmental technologies - a link between Europe and China: proceedings of the conference, 1st Annual International Conference Environment and Economy, Ljubljana, March 21st 2005, Anton Žove, ed., Ljubljana, Chamber of Commerce and Industry of Slovenia, Slovene Environmental Cluster, 2005, pp. 13-18.
2. Andrej Stergaršek, Iztok Hrastel: Flue gas desulphurisation research and industry applicatin. The economic impact of environment protection, Environmental technologies - a link between Europe and China: proceedings of the conference, 1st Annual International Conference Environment and Economy, Ljubljana, March 21st 2005, Anton Žove, ed., Ljubljana, Chamber of Commerce and Industry of Slovenia, Slovene Environmental Cluster, 2005, pp. 29-42.


### Regular Papers


1. Denis Arčon, Polona Umek, Pavel Cevc, Adolf Jesih, Christopher Paul Ewels, Alexandre Gloter: $NO_2$ gas adsorption on titania-based nanotubes. Electronic properties of novel nanostructures: XIX International Winterschool/Euroconference on electronic properties of novel materials(AIP conference proceedings, 786), Melville, New York, American Institute of Physics, 2005, pp. 335-339.
2. Tina Bunič, Melita Tramšek, Gašper Tavčar, Evgeny Goreshnik, Boris Žemva: Kovinski(II) heksafluorofosfati(V) s $XeF_2$ kot ligandom. Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, 8 pp.

3. Uroš Grošelj, Gašper Tavčar, David Bevk, Renata Jakše, Jurij Svete, Anton Meden, Boris Žemva, Branko Stanovnik: Študija reakcij (1R,4E,5S)-3-[(dimetilamino)metiliden]-1,8,8-trimetil-2-oksabiciklo[3.2.1]oktan -3-ona z elektrofili in nadaljnje pretvorbe nastalih produktov. Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, [1-8] pp.
4. Andrew Richard Hale, et al. (12 authors): Management influences on major hazard prevention: the ARAMIS audit. Advances in safety and reliability: proceedings of the European and Reliability Conference, (ESREL 2005), Tri City (Gdynia-Sopot-Gdańsk), Poland,27-30 June, 2005, Krzysztof Kołowrocki, ed., Leiden... [etc.], A.A. Balkema, Taylor & Francis, pp. 767-773.
5. Davor Kontić, Branko Kontić, Marko Gerbec: Testing of the ARAMIS methodology in Slovenia - process and results. Safety and security engineering: [First International Conference on Safety and Security Engineering, 2005](WIT transactions on the built environment, vol. 82), Southampton, Boston, WIT Press, cop. 2005, pp. 319-328.
6. Zoran Mazej: Novi ternarni indijevi(I) fluoridi, $InMF_6$ (M=P, As, Sb). Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, 4 pp.
7. Maja Ponikvar, Joel F. Liebman: Stabilnost $(PnF_6)^-$ (Pn =P, As, Sb, Bi) zvrsti v vodnem mediju. Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, p. 4 pp.
8. Andrej Stergaršek, Marko Gerbec, Robert Kocjančič, Iztok Hrastel: Optimised integrated FGD process. Proceedings of the International Conference on Coal Science and Technology 2005,ICCS&T Okinawa: October 9-14,2005 Okinawa, Japan, [S.l.], International Energy Agency, 2005, 20 pp.
9. Gašper Tavčar, Boris Žemva: Pregled nekaterih kadmijevih spojin s šibko koordinirajočimi anioni. Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, 6 pp.
10. Melita Tramšek, Gašper Tavčar, Primož Benkič, Boris Žemva: Molekule HF in hidrogenfluoridni anioni ($(HF_2)^-$ in $H_2(F_3)^-$) v spojinah kovinskih fluoroarzenatov(V). Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, 4 pp.
11. Polona Umek, Pavel Cevc, Boštjan Jančar, Adolf Jesih, Miran Čeh, Denis Arčon: Synthesis and characterisation of titania based nanotubes and nanoribbons. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, "Jožef Stefan" Institute, 2005, pp. 179-180.

## THESIS

### Ph. D. Thesis

1. Gašper Tavčar: Binary fluorides as ligands in compounds with weakly coordinating anions (Boris Žemva)

# INTERNATIONAL PROJECTS

1. Functionalised Metal Fluorides
   FUNFLUOS
   6. FP; NMP3-CT-2004-505575
   EC; Humboldt-Universität zu Berlin, Berlin, Germany
   Dr. Tomaž Skapin
2. Sharing Experience on Risk Management (Health, Safety, Environment) to prepare Future Industrial Systems
   SHAPE-RISK
   6. FP; NMP2-CT-2003-505555
   EC; Institut National de l'environnement industriel et des risques, Verneuil en Halatte, France
   Dr. Marko Gerbec, Asst. Prof. Branko Kontič
3. Worldwide Remediation of Mercury Hazards through Biotechnology
   BIOMERCURY
   6. FP; NMP2-CT-2004-505561
   EC; Gesellschaft für Biotechnologische Forschung MBH, Braunschweig, Germany
   Dr. Andrej Stergaršek, Prof. Milena Horvat
4. Plasma Polymers and Related Materials
   COST 527; EC
   Dr. Adolf Jesih
5. Experimental and Quantum Theoretical Studies of Inorganic Materials and Processes related to Catalysis
   BI-MK/05-06-001
   Dr. Ljupčo Pejov, Institute of Chemistry, Faculty of Science, Skopje, Macedonia
   Dr. Tomaž Skapin
6. Development of Low Cost Flue Gas Desulphirization (FGD) Technology
   BI-ROM-05-07-010
   Boita Corina, Institute for Studies & Power Engineering (ISPE), Bucharest, Romania
   Dr. Andrej Stergaršek
7. Chemical Processes in Plasma
   BI-SC/04-05-040
   Dr. Zoran Petrović, Institut za fiziku Beograda, Zemun, Belgrade, Serbia and Montenegro
   Dr. Adolf Jesih

# R & D GRANTS AND CONTRACTS

1. Development of the methods for determination of fluoride in food, organic mateter and soil
   Prof. Boris Žemva, Dr. Maja Ponikvar
2. Metal fluorides with specific surface properties
   Prof. Boris Žemva, Dr. Gašper Tavčar
3. Development and preparation of the Graetzl type photoelectrochemical cells
   Prof. Boris Žemva
4. Syntheses of 1D inorganic nanostructures, bionanostructures and the preparation of composites
   Dr. Adolf Jesih
5. Recycling and reuse of wastes
   Dr. Andrej Stergaršek

# RESEARCH PROGRAM

1. Inorganic chemistry and technology
   Prof. Boris Žemva

# NEW CONTRACTS

1. Preliminary risk assessment for planned natural gas pipelines in Slovenia
   Geoplin plinovodi, d. o. o.
   Dr. Marko Gerbec
2. Natural science for youth – attraction or dullness
   Ministrstvo za visoko šolstvo,znanost in tehnologijo
   Tomaž Ogrin, M. Sc.
3. Research and development of technologies for environmental protection
   Giz - ekološki grozd Velenje
   Dr. Andrej Stergaršek
4. Experimental school of chemistry
   Ministrstvo za šolstvo in šport
   Prof. Boris Žemva
5. Development of an ammunition management system in Slovenian army
   Ministrstvo za obrambo RS
   Prof. Boris Žemva

# VISITORS FROM ABROAD

1. Prof. Dr. Zoran Lj. Petrović, Institute of Physic, Beograd, Serbia and Montenegro, February 7–11, 2005
2. Dr. Maja Radetić, Faculty of Technology and Metallurgy, Beograd, Serbia and Montenegro, February 7–11, 2005

# STAFF

**Researchers**
1. Dr. Yevheniy Horyeshnik
2. Dr. Adolf Jesih
3. Dr. Zoran Mazej
4. Dr. Tomaž Skapin
5. Dr. Melita Tramšek
6. **Prof. Boris Žemva**, Head**

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8. Dr. Maja Ponikvar
9. Dr. Gašper Tavčar

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13. Tomaž Ogrin***, M. Sc.
14. Dr. Andrej Stergaršek

**Technical and administrative staff**
15. Neda Hanc
16. Pero Kolobarić
17. Robert Moravec
18. *Franc Mrhar, retired 31. 12. 2005*
19. Marija Toplak
20. Mira Zupančič

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# 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. In the field of organic chemistry, attention is mainly directed towards halogenated, in particular fluorinated, organic molecules.***

Head:
***Dr. Ingrid Milošev***

**Experimental research in the field of electrochemistry** was devoted to materials important in biomedical and technological applications. We studied the passivation mechanism, based on the formation of an oxide layer, of Cu-xZn alloys in alkaline chloride solutions. The composition of the oxide layer changes from $Cu_2O$/CuO on copper to ZnO/$Cu_2O$/CuO on Cu-xZn alloys. The improved corrosion resistance of Cu-xZn alloys in comparison to zinc metal was ascribed to the advantageous formation of a Cu-rich sub-layer, resistant to corrosion at negative potentials at which zinc metal is otherwise susceptible to corrosion. In the field of corrosion inhibition we intensified our research on benzotriazole and its derivates as possible inhibitors for Cu-xZn alloys and zinc metal in chloride-containing solutions.

Experimental studies of biomedical materials were oriented towards total hip replacements and are carried out in collaboration with the Orthopaedic Hospital Valdoltra. Local and systemic effects of articulation of metal components in the human body were investigated. Local effects are reflected in periprosthetic tissue, where micro- and nanometre sized wear debris is accumulated (Figure 1). Histological studies are performed in collaboration with the Faculty of Medicine. Systemic effects were evaluated through measurements of metal serum levels. Emerging concerns accompanying the reintroduction of metal-on-metal total hip prostheses are related to the possibility of increases in Co and Cr serum levels and, therefore, a careful surveillance of these patients is recommended. Three groups of patients with Sikomet metal-on-metal prostheses were studied, and the correlation between the increased metal serum levels and the presence of metal-on-metal bearings was proved. The biological impact of these results remains to be elucidated.

**Theoretical physico-chemical investigations of gas-phase elementary processes** were directed to the characterization of the potential energy surface of the $NO_2$ + Br reaction. The association reaction results in the formation of stable adducts, either $BrNO_2$ or BrONO isomers, proceeding without an entrance barrier. The isomerization of the less-stable BrONO to more-stable $BrNO_2$ was shown to be unlikely due to the high energy barrier. A new equilibrium, hypervalent OBrNO structure was characterised. A comparison with the analogous chlorine reaction revealed that particular elementary processes are more likely for the bromine system. Further, we computed the vertical excitation energies and oscillator strengths of BrONO and ClONO species, useful in explaining their UV spectra. The excited states up to about 7 eV were examined; higher states are considered to be unimportant in view of stratospheric photochemistry. When the vertical excitation energies for the prominent $2^1A'$ and $4^1A'$ states of ClONO and BrONO are compared, it is seen that the transitions lie about 0.6 eV higher, i.e., red-shifted, if bromine is replaced by chlorine. Low-lying excited states of both BrONO and ClONO are highly repulsive in the halogen-N coordinate, implying direct and fast photo-dissociation to $NO_2$ and halogen atoms, rather than via the N-O coordinate which would lead to NO and halogen-oxide fragments.

**BrONO has more excited states that are accessible to solar radiation in the lower stratosphere than its chlorine analogue.**

We have continued with the *ab-initio* investigation of **elementary processes on transition metal surfaces** using density-functional-theory electronic structure calculations. Adsorption and thermal decomposition of nitrous oxide, $N_2O$, with monocrystal Pd(110) and Rh(110) surfaces have been investigated. $N_2O$ is an intermediate in the removal of $NO_x$ in automobile three-way catalysts. Its decomposition on rhodium and palladium has attracted much attention, as these metals are good catalysts and $N_2O$ is the main by-product in this process. We have simulated STM (scanning-tunnelling-microscopy) images of the adsorbed $N_2O$ on Pd(110) with the aim of facilitating the interpretation of experimental STM images. The orientation of $N_2O$ on Pd(110) has thus been identified: in addition to the monomer form of the adsorbed molecule, $N_2O$ can also form clusters on the surface. We have also studied the interaction of ethylene and oxygen with silver surfaces. The epoxidation of ethylene catalyzed by silver is a very important heterogeneous catalytic process. We have found that less-coordinated surface silver atoms located near defects are more reactive, and are therefore the active reaction sites. Atomic oxygen adsorbed on the surface

influences the adsorption properties of the surface only slightly, while oxygen adsorbed into the subsurface influences the reactivity of the surface to a much larger extent.

**We have simulated STM images of adsorbed $N_2O$ on Pd(110) with the aim of facilitating the interpretation of experimental STM images. Thus the orientation of $N_2O$ on Pd(110) has been identified.**

New features have been added to the XCRYSDEN crystalline and molecular structure visualisation program (http://www.xcrysden.org/). The program is used by more that 1500 research laboratories worldwide.

**In the field of organic and bioorganic chemistry** we continued our work on the application of green reaction conditions to selective and efficient halogenation of organic compounds. We developed a method of iodination of alkenes using elemental iodine and a 30% aqueous hydrogen peroxide solution as the activator and reagent regenerator. We observed 100% atom-economy of iodine and $H_2O_2$,since only 0.5 equivalents of both chemicals were sufficient for total conversion of starting alkene to iodinated product. We also developed a method for direct a-iodination of ketones by elemental iodine and 30% aqueous hydrogen peroxide. Total atom-economy for iodine was established, while catalytic amounts of acid were found to be necessary for these reactions. We developed a method for radical bromination of alkyl-substituted aromatic compounds by NBS under visible-light activation. We associated the fluorous 'phase–vanishing' method with visible-light activation for benzylic bromination of organic compounds by bromine. We discovered and developed a new synthetic method for preparation of α,α-difluoro ketones. Ketones bearing activated methylenic positions were transformed with butylamine to a N-butylimine derivative which was treated with Selectfluor F-TEDA-$BF_4$ in acetonitrile thus forming α,α-difluoro ketones with a high yield.

We studied the reactions of alkenes with Selectfluor F-TEDA-$BF_4$ and evaluated the parameters regulating these reactions: the structure of the starting alkene, the solvent, the external nucleophile, and the temperature. We measured the kinetic and activation parameters and proposed the reaction pathway of these transformations.

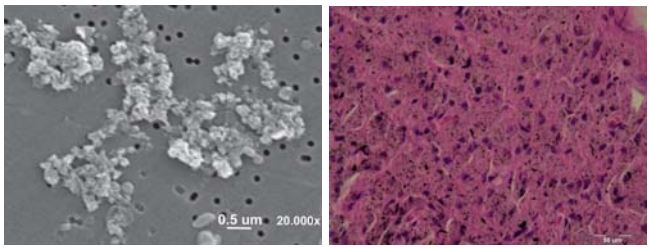


*Figure 1: Nanometre-sized wear particles of Ti6Al4V alloy isolated from periprosthetic tissue of total hip replacement patients and their histological image in the tissue*

Using fluorinated alcohols as solvents and activators for hydrogen peroxide we developed a direct method for the synthesis of cyclic tetraoxanes from ketones by oxidation with 30% aqueous $H_2O_2$. We determined the anti-malarial action of these compounds towards *Plasmodium falciparum* and studied the effect of solvent polarity on their *in-vitro* activity. Molecular iodine was found to be a catalyst for direct oxidation of ketones to dihydroperoxides by 30% $H_2O_2$.

On the invitation of the editorial board we contributed a review article to the first issue of the newly designed edition of Acta Chimica Slovenica on the subject of Selectfluor F-TEDA-$BF_4$ as a versatile mediator or catalyst in organic chemistry.

## Some outstanding publications in the past three years


1. A. Lesar, S. Prebil, M. Mühlhäuser and M. Hodošček, Conformational potential energy surface of BrOONO, Chemical Physics Letters, 368 (2003), 399-407
2. I. Milošev, V. Pišot, P. Campbell, Serum levels of cobalt and chromium in patients with Sikomet metal-on-metal total hip replacements, Journal of Orthopaedic Research, 23 (2005), 526-535
3. A. Kokalj and T. Matsushima, A density-functional theory study of the interaction of $N_2O$ with Rh(110), J. Chem. Phys. 122 (2005) 034708-1-10.
4. J. Iskra, S. Stavber and M. Zupan, Use of a fluorous bridge for diffusion-controlled uptake of molecular chlorine in chlorine addition to alkenes, Chem. Commun. (2003), 2496-2497
5. G. Stavber, M. Zupan, M. Jereb and S. Stavber, Selective and Effective Fluorination of Organic Compounds in Water using Selectfluor F-TEDA-BF4, Organic Letters, 6 (2004), 4973-4976

# BIBLIOGRAPHY

## ORIGINAL ARTICLES


1. Nicola Bonini, Andrea Dal Corso, Anton Kokalj, Stefano de Gironcoli: On-surface and sub-surface oxygen adsorption on Ag(210): vibrational properties. Surf. sci., Vol. 587, pp. 50-54, 2005.
2. Jernej Iskra, Daniéle Bonnet-Delpon, Jean-Pierre Bégué: Comparative study of the ring opening of 1-$FC_3$-epoxy ethers mediated by Brönsted acids and hexafluoro-2-propanol. J. fluorine chem., Vol. 126, pp. 551-556, 2005.
3. Marjan Jereb, Jernej Iskra, Marko Zupan, Stojan Stavber: Direct α-iodination of ketones induced by aqueous hydrogen peroxide. Letters in organic chemistry, Vol. 2, pp. 465-468, 2005.
4. Marjan Jereb, Marko Zupan, Stojan Stavber: Hydrogen peroxide induced iodine transfer into alkenes. Green chem. (Print), Vol. 7, pp. 100-104, 2005.
5. Aleksandra Kocijan, Ingrid Milošev: Raziskave pasivnih plasti na dveh kobaltovih zlitinah in njunih kovinskih komponentah z elektrokemijsko impedančno spectroskopijo. Mater. tehnol., Vol. 39, no. 5, pp. 133-142, 2005.
6. Anton Kokalj, Tatsuo Matsushima: A density-functional theory study of the interaction of $N_2O$ with Rh(110). J. chem. phys., Vol. 122, pp. 034708-1-034708-10, 2005.
7. Tadeja Kosec Mikić, Ingrid Milošev, Boris Pihlar: Passivity and corrosion of Cu-xZn (x=10-40 wt%) alloys in borate buffler containing chloride ions. J. Appl. Electrochem., Vol. 35, pp. 975-984, 2005.
8. Saša Kovačič, Antonija Lesar, Milan Hodošček: Density functional characterization of the potential energy surface of the $NO_2$ + Br reaction. Chem. Phys. Lett., Vol. 413, pp. 36-41, 2005.
9. Saša Kovačič, Antonija Lesar, Milan Hodošček: Quantum mechanical sudy of the potential energy surface of the ClO + $NO_2$ reaction. J. chem. inf. comput. sci., Vol. 45, pp. 58-64, 2005.
10. Antonija Lesar, Saša Kovačič, Milan Hodošček, Max Mühlhäuser, Sigrid Peyerimhoff: Electronic spectrum and photodissociation of ClONO in comparison to BrONO. J. phys. chem., A Mol. spectrosc. kinet. environ. gen. theory, Vol. 109, pp. 10357-10362, 2005.
11. Antonija Lesar, Saša Kovačič, Milan Hodošček, Margret Stadler, Max Mühlhäuser, Sigrid Peyerimhoff: Low-lying exiceted states and photodissociation studies of cis-BrONO. Mol. phys., Vol. 103, pp. 2375-2380, 2005.
12. Yunsheng Ma, Anton Kokalj, Tatsuo Matsushima: Inclined $N_2$ desorption in $N_2O$ reduction by $D_2$ and CO on Pd(110). PCCP. Phys. chem. chem. phys. (Print), Vol. 7, pp. 3716-3722, 2005.
13. Ingrid Milošev, Venčeslav Pišot, Pat Campbell: Serum levels of cobalt and chromium in patients with Sikomet metal-metal total hip replacements. J. Orthop. res., Vol. 23, pp. 526-535, 2005.
14. Ingrid Milošev, Rihard Trebše, Simon Kovač, Andrej Cör, Pat Campbell: Dissociation of the metal inlay from the polyethylene liner in an uncemented threaded cup. Arch. orthop. trauma surg., Vol. 125, pp. 134-141, 2005.
15. Maja Papež Iskra, Marko Zupan, Stojan Stavber: The effect of reaction conditions on activation parameters for the mild introduction of fluorine into phenyl substituted alkenes with SelectfluorTM F-TEDA-$BF_4$. Acta chim. slov., Vol. 52, pp. 200-206, 2005.
16. Igor Pravst, Marko Zupan, Stojan Stavber: Efficient synthesis of α,α-difluoro ketones using Selectfluor™ F-TEDA-$BF_4$. Synthesis (Stuttg.), no. 18, pp. 3140-3146, 2005.
17. Stojan Stavber, Marko Zupan: Selectfluor™ F-TEDA-$BF_4$ as a versatile mediator or catalyst in organic chemistry. Acta chim. slov., Vol. 52, pp. 13-26, 2005.
18. Rihard Trebše, Ingrid Milošev, Simon Kovač, Martin Mikek, Venčeslav Pišot: Poor results from the isoelastic total hip replacement: 14-17-year follow-up of 149 cementless prostheses. Acta Orthop Scand, Vol. 76, pp. 169-176, 2005.
19. Kazuo Watanabe, Anton Kokalj, Yoshiya Inokuchi, Izabela Rzeźnicka, Keijiro Ohshimo, Nobuyuki Nishi, Tatsuo Matsushima: Orientation of nitrous oxide on palladium (1 1 0) by STM. Chem. Phys. Lett., Vol. 406, pp. 474-478, 2005.
20. Rihard Trebše, Ingrid Milošev, Vesna Levašič: Letters to the editor. J Arthroplast, Vol. 20, pp. 960-961, 2005.


## PUBLISHED CONFERENCE PAPERS

### Invited Paper


1. Jernej Iskra: Hydrogen peroxide in fluorinated alcohols: a potent and selective oxidative system: presented at 15th International Symposium on Fine Chemistry and Functional XV) & IUPAC 1st International Symposium on Novel materials and Synthesis (NBS-1), October 17-20,2005, Shanghai, China. Fudan xuebao (Ziran Kexue ban), Vol. 44, pp. 697-698, 2005.


### Regular Papers


1. Saša Kovačič, Antonija Lesar, Milan Hodošček: ClONO loss mechanism in the presence of $NO_2$: a quantum-mechanical study. Advances in computational methods in sciences and engineering 2005: selected papers from the International Conference of Computational Methods in Sciences and Engineering 2005 (ICCMSE 2005), [21st-26th October 2005, Loutraki, Greece]: recognised conference by the European Society of Computational Methods in Sciences and Engineering (ESCMSE)(Lecture series on computer and computational sciences, vol. 4A), Theodore Simos, ed., George Maroulis, ed., Leiden, Brill Academic Publisher, 2005, pp. 295-298.
2. Jasminka Pavlinac, Marko Zupan, Stojan Stavber: Halogeniranje nekaterih biomimetskih molekul iz skupine metoksi substituiranih benzenovih derivatov. Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, 9 pp.
3. Ajda Podgoršek, Stojan Stavber, Jernej Iskra: Uporaba tekoče fluorne membrane za difuzijsko kontrolirano bromiranje metilbenzenskih derivatov z bromom. Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, 7 pp.
4, Katja Žmitek, Stojan Stavber, Marko Zupan, Jernej Iskra, Daniéle Bonnet-Delpon, Sebastien Charneau, Phillipe Grellier: Sinteza antimalarijsko aktivnih tetraksanov in povezava njihove strukture z aktivnostjo. Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, 7 pp.


## THESIS

### M. Sc. Thesis


1. Tadeja Kosec Mikić: Passivation and corrosion processes on Cu-xZn alloys in alkaline solutions (Dr. Ingrid Milošev)


# INTERNATIONAL PROJECTS

1. New Fluorous Media and Processes for Cleaner and Safer Chemistry
   COST D29 (Working Group 0011-03)
   EC
   Dr. Jernej Iskra
2. Psi-K: Towards Atomistic Materials Design
   ESF, Strasbourg Cedex, France
   Dr. Anton Kokalj
3. Investigation of Photochemical Properties of Molecules Important for Atmospheric Chemistry, Especially Bromine and Nitrogen Containing Compounds
   SI-AT/04-05/020
   Prof. Max Muehlhaeuser, Management Center Innsbruck, Innsbruck, Austria
   Dr. Antonija Lesar
4. Tissue Response to Wear Debris from M/M Hip Prostheses
   BI-FI/04-05-002
   Prof. Yrjö Konttinen, Biomedicum Helsinki, Biomaterial and Tissue Engineering Group, Helsinki, Finland
   Dr. Milošev Ingrid
5. Physicochemical Behaviour of the Atmospheric Pollutants: Reaction of Plain and Chlorinated Metoxy and Methilperoxy Radicals with Nitrogen Oxide
   Dr. Agnie M. Kosmas, University of Ioannina, Department of Chemistry, Ioannina, Greece
   Dr. Antonija Lesar
6. An Effect of Adsorbed Oxygen on Dissociation of $N_2O$ on Rh(110) and Pd(110) Surfaces from First Principles: A Density Functional Theory Study
   SLO-JPN (RC 20438012)
   Prof. Tatsuo Matsushima, Hokkaido University, Laboratory of Surface Reaction Dynamics, Catalysis Research Center, Sapporo, Japan
   Dr. Anton Kokalj

# R & D GRANTS AND CONTRACTS

1. Local and systemic effects of articulation of metal components from total hip replacements
   Dr. Ingrid Milošev
2. Nanomaterials in electrochemical systems
   Dr. Ingrid Milošev

# RESEARCH PROGRAMS

1. Bioanorganic and bioorganic chemsitry
   Dr. Stojan Stavber
2. Micro- and nanostructured functional materials: development, physical and chemical characterization and simulation of processes
   Dr. Ingrid Milošev

# VISITOR FROM ABROAD

1. Malgorzata Figurska, Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland, 21. 11.–21. 12. 2005

# STAFF

**Researchers**

1. Dr. Milan Hodošček***
2. Dr. Jernej Iskra
3. Dr. Anton Kokalj
4. Dr. Antonija Lesar
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*** Member of industrial or other organisation

# ELECTRONIC CERAMICS DEPARTMENT

# K-5

***The Electronic Ceramics Department is active in the research of the synthesis, properties and applications of materials for electronics, mainly complex multifunctional materials and structures. The materials of interest include ceramic piezoelectrics, ferroelectrics, relaxors, 'conductive' oxides and materials for solid-oxide fuel cells (SOFCs). The emphasis is on controlling the properties governed by the chemical composition and structure on the nano-, micro- and macro-levels.***

Head:
***Prof. Marija Kosec***

**New materials: lead-free piezoelectrics and relaxors.** We continued research on the synthesis of alkaline niobates, namely the 'model' systems $Na_2CO_3/Nb_2O_5$ and $K_2CO_3/Nb_2O_5$ by diffusion couples. Between 500 to 700°C, the first reaction product at the interface between $Na_2CO_3$ and $Nb_2O_5$ is $Na_2Nb_4O_{11}$, which above 700°C further reacts with $Na_2CO_3$ to yield $NaNbO_3$. The reaction between $K_2CO_3$ and $Nb_2O_5$ is more complicated, a series of phases with different K/Nb ratios being formed at the interface and $KNbO_3$ appearing at/above 600°C.
Research on the solid-state single-crystal growth (SSCG) of $(K_{0.5}Na_{0.5})NbO_3$ (KNN) has begun. $KTaO_3$ was used as the seed material because it is isostructural with KNN. The first single crystal of KNN is shown in Figure 1.

**Synthesis of (nano) particles of multicomponent oxides in solution.** We systematically studied the synthesis of nanoparticles with the aim of controlling the morphology and attaining high chemical homogeneity. Nanoparticles of $La_2Zr_2O_7$ were synthesized from La-nitrate and Zr-alkoxide in an organic solvent. The powder is composed of loose agglomerates with a large amount of porosity, generated during the thermal decomposition of organic and nitrate groups, similar to combustion synthesis. Ceramics, prepared from the milled powder, reached 98% of theoretical density after sintering at 1400°C, which is at least 100°C lower than the temperatures commonly reported for this material.

We studied the effect of hydrolysis conditions ($R_W = n\,H_2O/n\,Pb(CH_3COO)_2$ = 2-15, pH = 5 and 12) for the alkoxide-acetate precursor of $Pb(Zr_{0.5}Ti_{0.5})O_3$ and the binary compounds of this solid solution. The morphology, thermal decomposition and crystallization of $PbTiO_3$ are not affected by the hydrolysis conditions. In contrast, for $PbZrO_3$ both $R_W$ and pH strongly influence all three: in neutral pH, the reaction products are gel fragments, while at a high pH and a high Rw a few 10-nm-sized particles are formed.

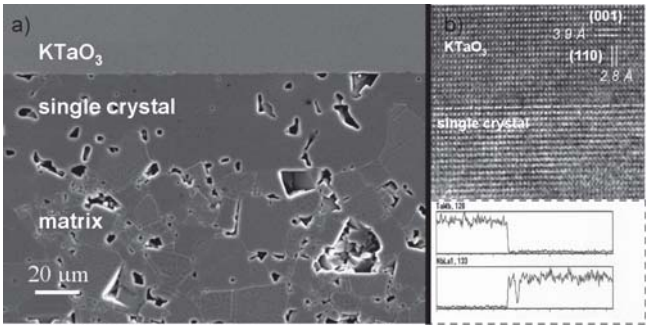


*Figure 1: a) Single-crystal growth of KNN Micrograph of the cross-section of the sample after annealing. The sample consists of the <001 > oriented $KTaO_3$ seed crystal, a single porous crystal layer and matrix grains which surround the single-crystal layer. b) Transmission electron microscope analysis has shown that the orientation of the crystal is identical with the orientation of the embedded seed and that Ta has not migrated from the seed into the grown crystal. Below the high-resolution image of the $KTaO_3$/single-crystal boundary, Ta and Nb EDS analysis across the seed and single crystal is shown.*

**High-energy milling or mechano-chemical synthesis** is an interesting method for the synthesis of nano-particles. Models for mechano-chemical synthesis of alloys integrate milling variables, such as the number and diameter of milling bodies, and disk rotation speed, into the mathematical relations that allow us to calculate the energy and frequency of ball impacts in a planetary mill. The milling diagrams obtained help us to determine the experimental conditions under which the target material is to be synthesized. We composed the milling diagram for $NaNbO_3$ and found that the mechano-chemical reaction between $Na_2CO_3$ and $Nb_2O_5$ is triggered at a critical cumulative kinetic energy. With this diagram we showed that mathematical models can be used to describe the mechano-chemical reactions in oxide systems (Figure 2).

We studied the synthesis mechanism of the $0.65\,Pb(Mg_{1/3}Nb_{2/3})O_3$–$0.35PbTiO_3$ (PMN-PT) solid solution during high-energy milling. The direct synthesis of PMN-PT is enabled by amorphisation and particle size reduction. A minor amount of the transient pyrochlore phase, formed at the early stages of milling, gradually transforms into the perovskite phase.

**In 2005 the research programme of the Electronic Ceramics Department was chosen as being among the best research programmes in Slovenia.**

Research on the **chemical solution deposition of ferroelectric thin films** based on $Pb(Zr_{0.30}Ti_{0.70})O_3$ (PZT) focused on the correlation between the chemical composition of the sols for film deposition and the crystallization of the perovskite phase at 400°C. Thin films on Pt/Si substrates are prepared from the sols based on lead oxide and transition-metal alkoxides in 2-methoxyethanol, and crystallize in the perovskite phase with (111) orientation. Upon heating, the decomposition of alkoxide groups

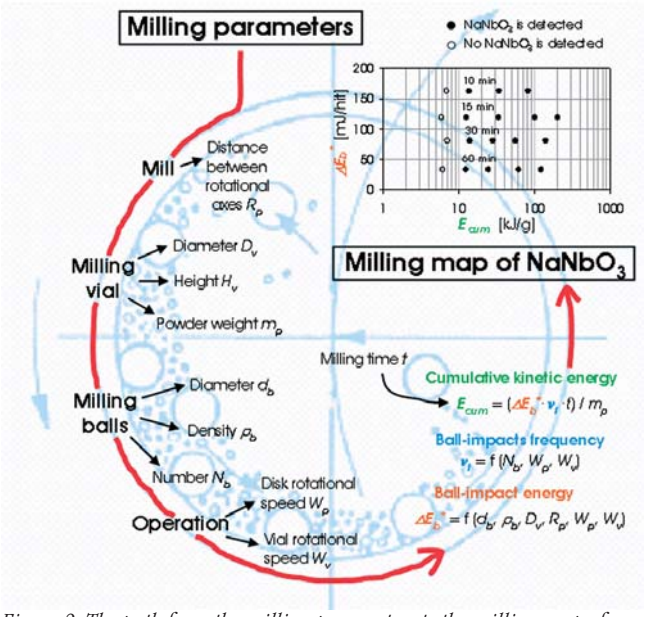


*Figure 2: The path from the milling parameters to the milling map of $NaNbO_3$. The process of high-energy ball-milling is characterized by nine milling parameters in total. From the milling parameters and the milling time we calculated the ball-impact energy, the ball-impacts frequency and the cumulative kinetic energy using the models developed for mechanical alloying. In order to synthesize $NaNbO_3$ from the powder mixture of $Na_2CO_3$ and $Nb_2O_5$, the milling parameters were set to different values so that different ball-impact energies were applied. The milling map is a plot of the ball-impact energy versus the cumulative kinetic energy. $NaNbO_3$ appears in the powder mixture after different milling times according to the ball-impact energy used. It is formed at a critical cumulative kinetic energy of about 10 kJ/g, which is constant irrespective of the ball-impact energy applied.*

within the bulk of the films causes a locally strongly reducing atmosphere. As a consequence, $Pb^{2+}$ is partially reduced to $Pb^0$, which further forms a Pt-Pb phase at the film/Pt interface at about 350–400°C. This transient phase acts as a nucleation layer for the (111) oriented perovskite phase. Thin films, prepared from the sols based on lead acetate crystallize, by self-textured growth, in the perovskite phase with (100) orientation. In this case, the thermal decomposition of acetate and alkoxide groups results in a less-reducing atmosphere in the bulk of the films, therefore the Pt-Pb phase is formed to a lesser extent or not at all, and does not act as a nucleation layer (Figure 3).

Research on $Ba_{0.3}Sr_{0.7}TiO_3$ has commenced. The films were prepared from solutions based on alkaline-earth acetates and Ti-alkoxides in organic solvents and deposited on sapphire substrates. The perovskite phase crystallizes at 700°C. The films exhibit a non-linear dependence of permittivity on electric field, i.e., tunability in the microwave range.

In the area of **thick-film technology, materials and sensors**, we investigated the properties of temperature sensors based on resistors with positive and negative temperature coefficients. The change in their response is a consequence of the film reacting with the low temperature co-fired ceramic (LTCC) substrates.

In the area of **mechanical response sensors and actuators** we studied the functional characteristics of PZT films on LTCC substrates. PZT reacts with the glassy phase from LTCC upon annealing and as a consequence its dielectric and piezoelectric responses are changed. A barrier layer between the PZT film and LTCC, based on PZT, diminishes this interaction and the functional response of the PZT film is improved. With finite-element modelling (FEM) we simulated different actuator structures composed of thick piezoelectric films on ceramic substrates such as alumina or LTCC for ceramic micro-electro-mechanical systems (C-MEMS) and their response to a signal voltage. We fabricated simple actuators, composed of PZT film on alumina, and by different characterization methods confirmed the modelling results.

We continued the research of **new environment-friendly materials** for hybrid thick-film circuits with the emphasis on reliability. Lead-free solders based on Sn/Ag/Cu alloys were investigated. In collaboration with the industrial partner Hyb d.o.o. we designed and fabricated the first hybrid circuit with thick-film materials and discrete components without hazardous materials, in agreement with RoHS (Restriction of use of Hazardous Substances).

**Crystallization of $Pb(Zr,Ti)O_3$ thin films on platinized silicon substrates, prepared by chemical solution deposition, is influenced by different factors. We have shown that the orientation of the perovskite phase is effectively controlled by the choice of the ligands in the liquid precursor.**

**Phase relations** in $PbO–TiO_2–SiO_2$ system were studied in collaboration with colleagues from EPFL, Switzerland. This phase diagram is important for the design of the glassy phase in thick-film resistors with a low annealing temperature, between 500 and 600°C.

In the framework of the EZPLATE project, financed by AGFA-Gevaert, Belgium, we studied **photoactive inorganic materials**. We synthesized materials in the form of pellets and thick films and analysed the surface by XPS. By changing the oxidation state of the metal ions we prepared ceramics with appropriate hydrophyllicity, which changes under illumination and as such is the basis for off-set printing.

The above research was conducted in the framework of the research programme, two ARRS projects, co-financed by Slovenian industry, and nine EU projects. In 2005 the research programme within the Electronic Ceramics Department was chosen as being among the best research programmes in Slovenia (Figure 4).

## Some outstanding publications in the past three years


1. A. Degen and M. Kosec, Influence of pH and ionic impurities on the adsorption of poly(acrylic) dispersant onto a zinc oxide surface, J. Am. Ceram. Soc., 86 (2003), 2001-2010.
2. M. Kosec, V. Bobnar, M. Hrovat, J. Bernard, B. Malič and J. Holc, New lead-free relaxors based on the $(K_{0.5}Na_{0.5})NbO_3$ - $SrTiO_3$ solid solution. J. Mater. Res., 19 (2004), 1849-1854.
3. M. Hrovat, D. Belavič, A. Benčan, J. Holc and G. Dražić, A characterization of thick-film PTC resistors, Sens. actuators, A, Phys., 117 (2005), 256-266.

4. D. Jenko, A. Benčan, B. Malič, J. Holc and M. Kosec, Electron microscopy studies of potassium sodium niobate ceramics. Microsc. Microanal., 11 (2005), 572-580.
5. B. Malič, M. Kosec, I. Arčon and A. Kodre, Homogeneity issues in chemical solution deposition of Pb(Zr,Ti)$O_3$ thin films. J. Eur. Ceram. Soc., 25 (2005), 2241-2246.

## Patents granted

1. Method for fabrication of KNN($K_{0.5}Na_{0.5}NbO_3$) ceramics with high density
   Janez Bernard, Barbara Malič, Janez Holc, Marija Kosec
   Patent no. 21798
2. Method for fabrication of complex lead-based perovskites
   Andrej Degen, Marija Kosec, Janez Holc, Barbara Malič, Silvo Drnovšek
   Patent no. 21797
3. Janez Holc, Barbara Malič, Silvo Drnovšek, Marija Kosec
   Preparation of Complex Perovskites by Mechanochemical Synthesis
   Patent no. 21556
4. Janez Holc, Silvo Drnovšek, Marko Hrovat, Marija Kosec
   Ferroelectric Thick Films on Reactive Ceramics
   Patent no. 21585
5. Sandi Kocjan, Janez Gramc, Alojz Simončič, Darko Pavlin, Marina Santo Zarnik
   Surface-Mountable Thick-Film Hybrid Module for Protection of a Telephone Line
   Patent no. 21770

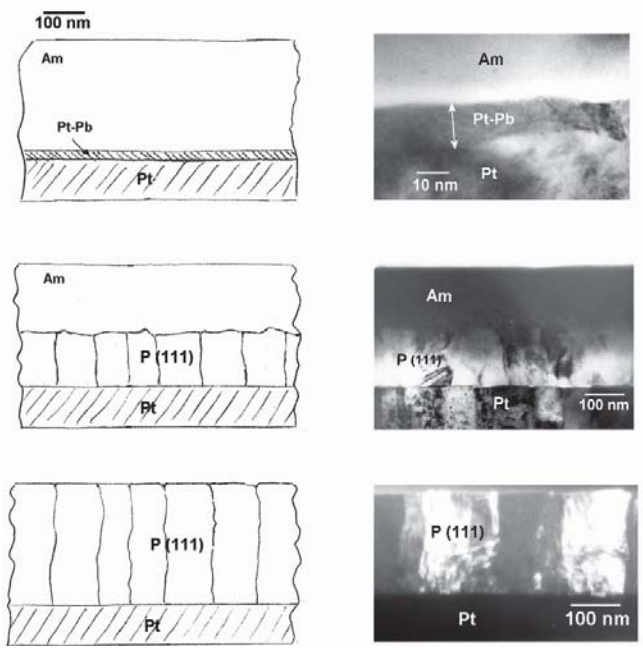


*Figure 3: Crystallization and microstructure evolution of (111) oriented perovskite phase in PZT 30/70 thin films: scheme and corresponding TEM micrographs (TEM: Goran Dražič) (P-perovskite phase, Am-amorphous phase).*

## Awards and appointments

1. Jerneja Godnjavec: Prešeren award for B. Sc. Thesis entitled: The influence of strontium addition on structure, microstructure and electrical properties of ($K_{0.5}Na_{0.5}$)$NbO_3$ ceramics
2. Marija Kosec: Admission in IEEE as a Senior Member
3. Marija Kosec: Society Award, MIDEM

*Figure 4: Almost complete group portrait of the Electronic Ceramics Department staff.*

## Organization of conferences, congresses and meetings

1. Electro-Active Materials and Sustainable Growth workshop (EMSG 2005), Abbey Les Vaux de Carney, France, May 25, 2005
2. 15th European Microelectronics and Packaging Conference & Exhibition, Brugge, Belgium, June 12 – 15, 2005
3. 4th Asian Meeting of Electroceramics (AMEC-4), Hangzhou, China, June 27 – 30, 2005
4. 41st International Conference on Microelectronics, Devices and Materials (MIDEM 2005), Ribno at Bled, Slovenia, September 14 – 16, 2005
5. 29th International Conference of International Microelectronics and Packaging Society, Koszalin-Darłówko, Poland, September 18 – 21, 2005
6. Slovenski kemijski dnevi 2005, Maribor, Slovenia, September 22 – 23, 2005

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### Regular Papers


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21. Artur Wymysłowski, Marina Santo-Zarnik, Darko Belavič: Sequential approach to numerical optimization of the LTCC ceramic pressure sensor. EuroSime 2005: Proceedings of the 6th International Conference on Thermal, Mechanical and Multi-Physics Simulation and Experiments in Micro-Electronics and Microsystems, April 18-19-20, 2005, Berlin, Germany, Piscataway, The Institute of Electrical and Electronics Engineers, 2005, pp. 376-383.
22. Artur Wymysłowski, Marina Santo-Zarnik, Darko Belavič: Tolerance design of the LTCC ceramic pressure sensor sensibility. Proceedings, Society, Poland chapter, Koszalin-Darłówko, 18-21 September 2005, [S.l.], International Microelectronic & Packaging Society, Poland chapter, 2005, pp. 397-400.

## THESES

### M. Sc. Thesis

1. Bernard Janez: Design and fabrication of piezoelectric actuator (Prof. Rihard Karba)

### B. Sc. Theses

1. Godnjavec Jerneja: The influence of strontium addition on structure, microstructure and electrical properties of $(K_{0.5}Na_{0.5})NbO_3$ ceramics (Prof. Stane Pejovnik, Prof. Marija Kosec)
2. Kržišnik Mojca: Structural characterization of the (K,Na)NbO3 - SrZrO3 system (Prof. Breda Mirtič, Prof. Marija Kosec)

## PATENT APPLICATION

1. Marina Santo Zarnik, Darko Belavič, Marko Hrovat, Marko Pavlin
   Thick film piezoresistive pressure sensor with a floating diaphragm
   Patent application no. P-200500209

# INTERNATIONAL PROJECTS

1. REliable, Tuneable and INexpensive Antennas by collective fabrication processes
   RETINA
   6. FP; AST4-CT-2005-516121
   EC; Dr. Volker Ziegler, EADS Deutschland GmbH, Corporate Research Centre, Dept. LG-ME, München, Germany
   Prof. Marija Kosec, Dr. Barbara Malič
2. Inexpensive, high-perforMance, lead-free piezoelectric crystals and their applications in transducers for ultrasonic Medical DIAgnostic and industrial Tools and Equipments
   IMMEDIATE
   6. FP; COOP-CT-2005-017569
   EC; Dr. Dragan Damjanovic, Ecole Polytechnique Federale de Lausanne, Swiss Federal Institute of Technology - EPFL, Ceramics Laboratory - LC, Materials Institute - IMX, Faculty of Engineering- STI, Lausanne, Switzerland
   Prof. Marija Kosec, Dr. Andreja Benčan Golob
3. Multifunctional & Integrated Piezoelectric Devices
   MIND
   6. FP; NMP3-CT-2005-515757
   EC;. Wanda Wolny, Ferroperm Piezoceramics A/S, KvistgĺrdDenmark
   Prof. Marija Kosec, Dr. Barbara Malič
4. Fuel Cell Application in a New Configurated Aircraft
   CELINA
   6. FP; AST4-CT-2005-516126
   EC; Wolfgang Dressel, Airbus Deutschland GmbH, Hamburg, Germany
   Prof. Marija Kosec, Dr. Danjela Kuščer Hrovatin
5. Removal of Hazardous Substances in Electronics: Processes and Techniques for SMEs
   GREENROSE
   6. FP; COLL-CT-2004-500225
   EC; Knut Aune, Abelia, Oslo, Norway
   Prof. Marija Kosec
6. Miniaturised Ultrasonic, Engineered-Structures and LTCC-Based Devices for Acoustics, Fluidics, Optics and Robotics
   MINUET
   6. FP; NMP2-CT-2004-505657
   EC; Wanda W. Wolny, Ferroperm Piezoceramics A/S, KvistgĺrdDenmark
   Prof. Marija Kosec, Dr. Janez Holc
7. Innovative Ceramic Processing
   CERAMOS, Marie Curie Training Site
   5. FP; HPMT-CT-2001-00372; EC
   Prof. Marija Kosec, Dr. Andreja Benčan Golob
8. Centre for Advanced Processing, Technologies and Materials for Ceramic Electro and Electromechanical Devices
   SICER; 5. FP; G1MA-CT-2002-04029; EC
   Prof. Marija Kosec, Dr. Barbara Malič
9. Polar Electroceramics
   POLECER; 5. FP; G5RT-CT-2001-05024
   EC; Wanda W. Wolny, Ferroperm Piezoceramics A/S, KvistgĺrdDenmark
   Prof. Marija Kosec, Dr. Barbara Malič
10. Chemical Solution Deposition of Thin Films
    COST 528; EC
    Prof. Marija Kosec
11. Electroceramics from Nanopowders produced by Innovative Methods – ELENA
    COST 539; EC
    Dr. Barbara Malič
12. Switchable Surfaces for Use in Truly Processless (WET) Offset Printing Plates
    EZPLATE
    CONF. 03265
    Dr. Ronn Andriesen, Agfa-Gevaert N. V., Mortsel, Belgium
    Prof. Marija Kosec, Dr. Danjela Kuščer Hrovatin
13. Processing and Microstructure Control of Electronic Ceramics
    BI-CN/06-07/01
    Dr. Hong Wang, Electronic Materials Research Laboratory, Key Lab of Ministry of Education of China, Xi'an Jiatong University, Xi'an, PR China
    Prof. Marija Kosec
14. New Synthesis Routes for Electronic Ceramics
    PROFKER
    BI-SC/04-05-025
    Prof. Biljana Stojanović, Centar za Multidisciplinarne Studije, Univerziteta u Beogradu, Belgrade, Serbia and Montenegro
    Prof. Marija Kosec
15. Reactions and Phase Equilibria in Oxide and Non-oxide Systems
    FARACEO
    Dr. Snežana Bošković, Institut za nuklearne nauke "Vinča", Belgrade, Serbia and Montenegro
    Dr. Marko Hrovat

# R & D GRANTS AND CONTRACTS

1. Hybrid Micro Electromechanical Systems
   Dr. Marko Hrovat
2. Capacitive Ceramic Pressure Sensors
   Dr. Marko Hrovat
3. Hybrid Materials and Structures
   Dr. Janez Holc
4. Nanostructured Surfaces and Interfaces
   Dr. Barbara Malič

# RESEARCH PROGRAM

1. Electronic Ceramics, Nano, 2D and 3D Structures
   Prof. Marija Kosec

# VISITORS FROM ABROAD

1. Dr. Paul Bowen, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland, January 18–21, 2005
2. Dr. Yongli Wang, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland, February 20–March 12, 2005
3. Dr. Artur Wymyslowski, Wrocław University of Technology, Wrocław, Poland, March 14–17, 2005
4. Dr. Theodor Schneller, Institut für Werkstoffe der Electrotechnik II, Aachen, Germany, April 18–24, 2005
5. Fabien Remondiere, B. Sc., Sciences des Procédés Ceramiques et de Traitements de Surface, Université de Limoges, Limoges, France, June, 1–July, 31, 2005
6. Rasmus Lou Moeller, B. Sc., Ferroperm, Kvistgĺrd, Denmark, June 12–19, 2005
7. Slavica Zec, M. Sc., Laboratorij za materiale, Institut za nuklearne nauke Vinča, Belgrade, Serbia and Montenegro, June 19–23, 2005
8. Dušan Bučevac, B. Sc., Laboratorij za materiale, Institut za nuklearne nauke Vinča, Belgrade, Serbia and Montenegro, June 19–24, 2005
9. Viorica Stancu, B. Sc., National Institute of Materials Physics, Magurele, Romania, June 26–July 12, 2005
10. Joanna Skrzypek, B. Sc., University of Silesia, Faculty of Informatics and Materials Science, Sosnowiec, Poland, July 1–January 31, 2006
11. Luminita Predoana, B. Sc. , Institute of Physical Chemistry, Bucharest, Romania, June 1–December 31, 2005
12. Prof. Toshio Ogawa, Shizuoka Institute of Science and Technology, Shizuoka, Japan, August 29, 2005
13. Vytautas Blechertas, B. Sc., Kaunas University of Technology, Kaunas, Lithuania, September 22–December 22, 2005
14. Prof. Marc Lethiecq, Ultrasound Group, Francois-Rebalais University, Tours, France, September 13, 2005
15. Dr. Luminita Amarande, National Institute of Materials Physics, Magurele, Romania, October 9–27, 2005
16. Prof. René Guinebretiere, Sciences des Procédés Ceramiques et de Traitements de Surface, Université de Limoges, Limoges, France, November 20–25, 2005
17. Dr. Konstantin Astafiev, Ferroperm, Kvistgĺrd, Denmark, December 15–20, 2005
18. Prof. Angus Kingon, North Carolina State University, Raleigh, USA, December 15–21, 2005

Long Term Visitors

1. Laila Čakare Samardžija, B. Sc., Institute of Solid State Physics – ISSP, University of Latvia, Riga, Latvia, July 31, 2000–August 31, 2006
2. Elena Daniela Ion, M. Sc., National Institute for Materials Physics, Magurele, Romania, March 18, 2004–September 30, 2007
3. Dr. Iulian Boerasu, National Institute for Materials Physics, Magurele, Romania, November 1, 2004–April 20, 2006
4. Luminita Predoana, B. Sc., Institute of Physical Chemistry, Bucharest, Romania, June 1–December 31, 2005
5. Fabien Remondiere, B. Sc., Sciences des Procédés Ceramiques et de Traitements de Surface, Université de Limoges, Limoges, France, June 1–July 31, 2005
6. Joanna Skrzypek, B. Sc., University of Silesia, Faculty of Informatics and Materials Science, Sosnowiec, Poland, July 1–January 31, 2006
7. Vytautas Blechertas, B. Sc., Kaunas University of Technology, Kaunas, Lithuania, September 22–December 22, 2005

# STAFF

**Researchers**

1. Dr. John Gerard Fisher
2. Dr. Janez Holc
3. Dr. Marko Hrovat
4. **Prof. Marija Kosec**, Head**
5. Dr. Danjela Kuščer Hrovatin
6. Dr. Barbara Malič
7. Dr. Marina Santo Zarnik***

**Postdoctoral associates**

8. Dr. Andreja Benčan Golob
9. Dr. Andrej Degen***
10. Dr. Mišo Vukadinović***

**Postgraduates**

11. Jerneja Godnjavec, B. Sc.
12. Darja Jenko, B.Sc.
13. Mira Mandeljc, M. Sc.
14. Tadej Rojac, B. Sc.
15. Hana Uršič, B. Sc.

**Technical officers**

16. Darko Belavič***, B. Sc.
17. Jena Cilenšek, B. Sc.
18. Silvo Drnovšek, B. Sc.
19. *Dubravka Ročak, M. Sc., retired August 8, 2005*
20. Tina Ručigaj, B. Sc.

**Technical and administrative staff**

21. Srečo Maček

** Part-time faculty member
*** Member of industrial or other organisation

# 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 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 on the development of alternative, cost-effective and environmentally friendly ceramic technologies.***

Head:
***Prof. Tomaž Kosmač***

Research on layered composites with ribbon-like microstructures, prepared with repeated rolling and folding of laminates made from paraffin pastes, and their subsequent sintering, was continued. Three different composites were fabricated-calcium phosphate/zirconia, aluminium titanate/mullite, and aluminium oxide/nickel - and it was shown that the mechanical properties of such composites after the transition from flat layered, to wavy ribbon-like microstructures, are much better than those of traditional particulate composites with a similar composition.

Theoretical research was carried out on the influence of geometric parameters on the percolation threshold for electrical conductivity in particulate composites made of a ceramic matrix and a conductive phase. We were especially interested in the material inhomogeneity aspect which aided us in the explanation of the functional properties of composites with ribbon-like microstructures. Geometrical parameters include the shape of the conducting particles and their space and orientation distributions, and also finite-size effects, such as decreased layer thicknesses, "conductivity bottle necks", etc. We applied the theoretical model to the interpretation of the measured electrical conductivity of layered composites $Cr/Al_2O_3$ with ribbon-like structure, and also in developing materials suitable for the production of ceramic glow plugs for diesel engines.

Within the study of the hydrolysis of AlN powder the mechanisms which led to the formation of a protective layer after the treatment of the powder with aluminium di-hydrogen phosphate were investigated. The results indicate that the phosphate anions bond to the AlN powder surface, and this is even more pronounced at higher temperatures, due to the formation of fresh hydrated powder surfaces. The latter was proved by FTIR spectroscopy of the powder surface before and after the coating with aluminium di-hydrogen phosphate.

**In 2005 the department cooperated in the organization of the international IX. ECERS Conference and Exhibition. We organised the Structural Ceramics and Bioceramics symposia.**

We started the investigation of nanostructured ceramic coatings with the aim of using them as protective layers from surrounding influences. The precipitation of metal hydroxides from super-saturated solutions onto substrate surfaces can be exploited for the preparation of such layers. We have found out, by controlling the precipitation conditions (temperature, duration, pH), that it is possible to prepare deposited layers with variable morphologies (nano- and micro-sized particles) which are preserved even after heat treatment at temperatures where the hydroxides convert into oxides.

We studied the densification and microstructure, and the corresponding mechanical properties and hydrothermal stability of tetragonal Y-TZP ceramics formed by the HAS process. Concentrated aqueous suspensions of $ZrO_2$ powder with the addition of 1-5 wt % of homogeneously dispersed AlN powder were injected into pre-heated non-porous moulds, where they solidified due to in-situ AlN hydrolysis. After drying, the green bodies were sintered and then their microstructure, mechanical properties, and hydrothermal stability were evaluated. We found that the presence of $Al_2O_3$, which is formed during the sintering of the samples, enhances the densification and grain growth, leading to improvement of toughness, hardness, and hydrothermal stability, while the bending strength is slightly decreased.

In investigations of dental ceramics based on tetragonal $ZrO_2$ we focused our attention on the pre-clinical tests of prototype dental posts with a core for affixing prosthetic crowns, which were developed in the cooperation with stomatologists from the Medical Faculty in Ljubljana. We investigated the influence of processing parameters on the strength and reliability of prototype posts, while the co-workers from Medical Faculty continued with clinical trials.

In the area of bio-ceramics we investigated the possibility of manufacturing particulate and layered Y-TZP/TCP composites. We also studied their bio-activity and hydrothermal stability. For the bio-activity test we used a method with super-saturated solution of calcium phosphate which has been mentioned for the first time only recently, and

is not recognised yet. This method is less time-consuming than standard methods with simulated body liquid. According to the results, nano-precipitates of hydroxy-apatite from the solution are formed on the surface of these composite materials, proving their bio-activity.

Within the European project 'Increasing the performance of total hip replacement prosthesis through functionally graded material innovation and design' we continued the research on $Al_2O_3/Al_2O_3$-$ZrO_2$ ceramics in the form of particulate and layered composites, fabricated by slip-casting with gypsum moulds. We paid special attention to the processing, and to the search for the influence of defects, especially the initiation and propagation of tunnelling cracks in multi-layered composites, on the mechanical properties. The formation of tunnelling cracks was explained by inappropriate ratios of the thicknesses of individual layers. We carried out theoretical studies of the bending strength of layered alumina/zirconia composites without large defects such as tunnelling cracks.

In the area of C/C-SiC composites with ceramic matrix gradient structures we studied the use of various polymer ceramic precursors for the preparation of these materials. We investigated the composite structure, interactions between individual constituents, and their thermal stability and mechanical properties. In the case of polymer ceramic precursors, we succeeded in fabricating composites with improved mechanical properties. However, after annealing at 1600 °C, the matrix decomposed and there was a large mass loss, leading to heavily reduced mechanical performance. We found that the addition of fillers (active or passive) can influence the decomposition of the matrix at higher temperatures, but the decomposition cannot be avoided completely. Therefore these composites are not suitable for use in combination with the infiltration of liquid silicon (LSI), which takes place at temperatures up to 1600 °C. On the other hand, these composites could be used for the fabrication of brake discs, immediately after the last pyrolysis cycle, without additional impregnation with silicon, through the use of various active and passive fillers. We continued the investigations of the brake pad surfaces, which are used in combination with brake discs from the C/C-SiC composite. We showed that after the pad and disc are heated to 1000 °C during braking, a very thin layer of mixed oxides is formed from the pad constituents on the surface of the brake pad. Furthermore, we explained the mechanism of the oxide formation and the influence of the number of braking events on the morphology of the oxide layers.

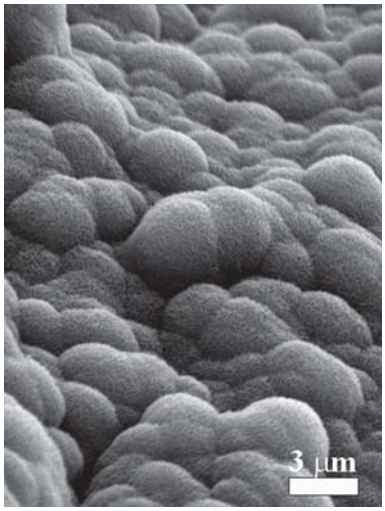


*Figure 1: Precipitates of calcium hydroxy-apatite on the surface of the $ZrO_2$ ceramic substrate, soaked in the simulated body fluid proved the bio-activity of the material.*

In the framework of the 'Multilayered composites for antiballistic protection based on SiC' project, we investigated the preparation of ceramic powder suspensions (silicon carbide, boron carbide and their mixtures) and the pyrolysis of pre-shapes and infiltration of silicon into porous moulds. For the suspension preparation, the type of dispersive medium, type and quantity of surface-active materials, and the size of the powder particles were varied. We showed that the choice of dispersive medium is the most important parameter in the preparation of these composites. The volume fraction of SiC in the composites is more than 80 %, however, since it is impossible to prepare the suspensions with such high volume fractions of powders, it is necessary to obtain the fraction of SiC mentioned above by the reaction of carbon, formed during pyrolysis of the dispersive medium, with the silicon during infiltration. We found that the most appropriate dispersive medium is polymeric pitch, which gives a very high content of residual carbon in the pre-shape after pyrolysis. The dimensions of the prepared samples change very little during the whole process ('net shape'), which enables a simple machining of the pre-shape, while additional, very difficult, machining of the infiltrated products is unnecessary.

In the area of new super-hard composite materials based on $AlMgB_{14}$-$xTiB_2$ (x = 0.05-0.3) compounds, we studied, in cooperation with the K9 department, the high-temperature synthesis of these precursors by reactive sintering of the starting elements or compounds B, Al, Mg, $TiB_2$, $AlB_{12}$, $MgB_2$, $TiB_2$ in a protective atmosphere at normal pressure. Using a new procedure we synthesized the compound $AlMgB_{14}$. The samples prepared with this compound were sintered by hot pressing with the addition of $TiB_2$, and then their hardness measured. The measured values were about 30 GPa, which is a great success, since similar values of hardness have only been obtained using expensive and time-consuming synthesis of the $AlMgB_{14}$ compound by mechanical alloying.

Besides the research work, the staff of the Engineering ceramics department conducted several R&D projects for industrial partners and other end-users of bio- and engineering ceramics. In the framework of our long-term cooperation with AET Tolmin we carry out research support of technological processes, with emphasis on improvement of quality and lowering costs. One of the goals was the improvement of certain parameters in the production of $Al_2O_3$ ceramics in the AET, e.g., better dimensional control, by optimization of the properties of aqueous suspensions and ceramic powders. The analysis of the size distribution and shape of starting powders (different aluminas and steatite) was made using a granulometer and a scanning electron microscope. The pH dependence of the zeta-potential of these powders in the aqueous suspensions was measured. One of the goals was the optimisation of the powder milling.

A relatively simple way of measuring the wear resistance of hard ceramics was developed and tested on $Al_2O_3$ ceramics synthesized by AET. The standard machine for grinding and polishing the ceramic samples was used. In this wear resistance test, the samples were subjected to abrasion with a 45 mm diamond paste under controlled

conditions (frequency of the rotation of polishing plate, the normal force between the plate and the samples, test duration) and the samples were precisely weighed before and after the test. The mass loss is the measure of wear resistance. Although the method is simple it gives repeatable results.

Research on materials that can be used for the production of a new generation of ceramic glow-plugs for diesel engines was done in cooperation with AET. The investigation was concerned with the type of materials suitable (AlN, SiC, $Y_2O_3$, WC, $MoSi_2$), production technologies (slip-casting in the gypsum mould, rolling the layers, compressing the powders), and the geometry of the plugs (cylindrical, flat). The mechanical properties (bending strength) and electric conductivity of prototype materials were measured, and, finally, laboratory simulations of the functioning of the prototype plug were carried out. AlN in SiC proved convenient materials for the insulating part and as the insulating matrix of the conducting part of the plug, while $MoSi_2$ is suitable as the conducting phase inside the insulating matrix of the conducting part of the glow-plug.

Cooperation with the company MS Production, Bled, on development of brake discs based on C/C-SiC composites, and of brake pads, was continued, with the cooperation being extended to research on multilayered composites based on SiC for antiballistic protection.

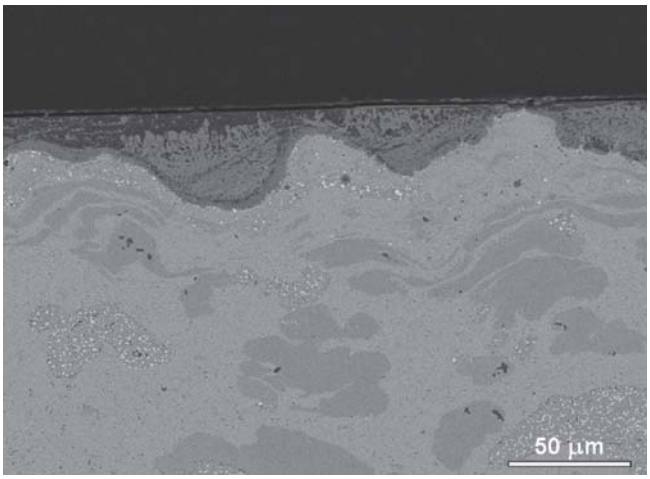


*Figure 2: Microstructure of the brake pad cross-section after the series of brakings using C/Si composite brake disc, which shows that plastic deformation and partial oxidation of the metal components occurred due to high temperatures during braking.*

## Some outstanding publications in the past three years

1. Kosmač Tomač. The densification and microstructure of Y-TZP ceramics formed using the hydrolysis-assisted solidification process. J. Am. Ceram. Soc., 2005, vol. 88, str. 1444-1447.
2. Valentina Medri, Marek Bracisiewicz, Kristoffer Krnel, Frederic Winterhalter, Alida Bellosi. Degradation of mechanical and electrical properties after long-term oxidation and corrosion of non-oxide structural ceramic composites. J. Eur. Ceram. Soc., 2005, vol. 25, str. 1723-1731.
3. M. Leverkoehne, Aleš Dakskobler, Matjaž Valant, R. Janssen, T. Kosmač. Cr-Al2 layered composites with a high electrical anisotropy prepared by repeated deformation processing. J. Eur. Ceram. Soc., 2005, vol. 25, str. 65-72.
4. Milan Ambrožič, Aleš Dakskobler, Matjaž Valant. Numerical analysis of steric influence on conductivity percolation threshold. EPJ, Appl. Phys., 2005, vol. 30, str. 23-31.
5. Kristoffer Krnel, Goran Dražić, Tomaž Kosmač. Degradation of AlN powder in aqueous environments. J. mater. res., 2004, vol. 19, str. 1157-1163.
6. Čedomir Oblak, Peter Jevnikar, Tomaž Kosmač, Nenad Funduk, Ljubo Marion. Fracture resistance and reliability of new zirconia posts. J Prosthet Dent, 2004, letn. 91, št. 4, str. 342-348.
7. Aleš Dakskobler, Tomaž Kosmač. The preparation and properties of $Al_2O_3$-$ZrO_2$ composites with corrugated microstructures. J. Eur. Ceram. Soc.. [Print ed.], 2004, vol. 24, str. 3351-3357.

## Organization of conferences, congresses and meetings

1. Aleš Dakskobler, Tomaž Kosmač, Kristoffer Krnel, Cooperation in the organization of the IX Conference & Exhibition of the European Ceramic Society, Portorož, Slovenia, June 19 – 23, 2005.

# BIBLIOGRAPHY

## ORIGINAL ARTICLES


1. Milan Ambrožič, Aleš Dakskobler, Matjaž Valant: Numerical analysis of steric influence on conductivity percolation threshold. EPJ, Appl. phys. (Print), Vol. 30, pp. 23-31, 2005.
2. Milan Ambrožič, Aleš Dakskobler, Matjaž Valant, Tomaž Kosmač: Percolation threshold model and its application to the electrical conductivity of layered $BaTiO_3$-Ni. Mater. Sci., Vol. 23, pp. 535-539, 2005.
3. Sabina Beranič, Saša Novak, Tomaž Kosmač, H. G. Richter, S. Hecht Mijić: The preparation and properties of functionally graded alumina/zirconia-toughened alumina (ZTA) ceramics for biomedical applications. Key eng. mater., Vol. 290, pp. 348-352, 2005.
4. Tomaž Kosmač: The densification and microstructure of Y-TZP ceramics formed using the hydrolysis-assisted solidification process. J. Am. Ceram. Soc., Vol. 88, pp. 1444-1447, 2005.
5. M. Leverkoehne, Aleš Dakskobler, Matjaž Valant, R. Janssen, Tomaž Kosmač: Cr-$Al_2$ layered composites with a high electrical anisotropy prepared by repeated deformation processing. J. Eur. Ceram. Soc., Vol. 25, pp. 65-72, 2005.
6. Valentina Medri, Marek Bracisiewicz, Kristoffer Krnel, Frederic Winterhalter, Alida Bellosi: Degradation of mechanical and electrical properties after long-term oxidation and corrosion of non-oxide structural ceramic composites. J. Eur. Ceram. Soc., Vol. 25, pp. 1723-1731, 2005.
7. Čedomir Oblak, Peter Jevnikar, Tomaž Kosmač, Nenad Funduk, Ljubo Marion: Lastnosti in uporaba zatičkov iz cirkonijeve oksidne keramike v fiksni protetiki. Zobozdravstveni vestnik, Letn. 60, No. 3/5, pp. 227-236, 2005.
8. Milan Ambrožič, Jakub Michalski, Sabina Beranič: Računalniška analiza mikrostrukture keramičnega materiala. Vakuumist, Let. 25, No. 1-2, pp. 13-15, 2005.

# PUBLISHED CONFERENCE PAPERS

## Invited Paper

1. Kristoffer Krnel, Zmago Stadler, Tomaž Kosmač: Preparation and properties of new C/C-SiC composites for braking systems: invited talk. NENAMAT international conference: NANO'05, November 8-10,2005, Brno, Czech Republic, Pavel Šandera, ed., Brno, University of Technology, 2005, pp. 49-56.

## Regular Papers

1. Tomaž Kosmač, Aleš Dakskobler: The preparation and properties of layered TCP/Y-TZP composites with ribbon-like microstructures. Proceedings of the 18th International Symposium on Ceramics in Medicine: the annual meeting of the International Society for Ceramics in Medicine (ISCM), Kyoto, Japan, 5-8 December 2005(Bioceramics, vol. 18)(Key engineering materials, vol. 309-311), Takashi Nakamura, ed., Kimihiro Yamashita, ed., Masashi Neo, ed., [Zuerich]... [et al.], Trans Tech Publications, cop. 2005, pp. 1145-1148.
2. Kristoffer Krnel, Tomaž Kosmač, Zmago Stadler: Razvoj novih C/C-SiC kompozitov za zavorne sisteme. Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, 11 pp.
3. Fedja Marušič, Kristoffer Krnel, Tomaž Kosmač: Raziskave materialov za pripravo keramične žarilne svečke. Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, 8 pp.
4. Zmago Stadler, Tomaž Kosmač, Kristoffer Krnel: Kemijske in fizikalne spremembe triboloških površin sintranih zavornih ploščic v paru s C/C-SiC kompozitnimi zavornimi diski. Slovenski kemijski dnevi 2005, Maribor, 22. in 23. september 2005, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2005, 11 pp.

# INTERNATIONAL PROJECTS

1. Network for Nanostructured Materials of ACC
   NENAMAT; 6. FP; INCO-CT-2003-510363
   EC; Emoeke Rudnayova, Institute of Materials Research - Slovak Academy of Sciences, Kosice, Slovakia
   Prof. Tomaž Kosmač
2. Innovative Ceramic Processing
   CERAMOS, Marie Curie Training Site
   5. FP; HPMT-CT-2001-00372
   EC; Prof. Tomaž Kosmač, Prof. Marija Kosec, Dr. Barbara Malič
3. Increasing the Performance of Total Hip Replacement Prostheses through Functionally Graded Material Innovation and Design
   BIOGRAD; 5. FP; G5RD-CT-2000-00354
   EC; Prof. Omer Van Der Biest, Katholieke Universiteit Leuven, Dept. of metallurgy and technology of materials, Leuven, Belgium
   Dr. Saša Novak Krmpotič, Prof. Tomaž Kosmač
4. Design and Development of Functionally Graded SiAlON Ceramics
   TR 04-07
   Prof. Hasan Mandal, Anadolu University, Faculty of Engineering and Architecture, Department of Materials and Engineering, Eskişehir, Turkey
   Prof. Tomaž Kosmač

# R & D GRANTS AND CONTRACTS

1. Development of light, superhard composite materials based on AlMgB14-xTiB2
   Dr. Kristoffer Krnel
2. Research of C/C-SiC ceramic matrix composites for braking sistems
   Dr. Kristoffer Krnel
3. Development of multifunctional B4C-Al and B4CMg composite materials for new products
   Prof. Tomaž Kosmač
4. Multilayered composites based on SiC for ballistic protection
   Dr. Aleš Dakskobler
5. Synthesis of nanoparticles and nanocomposites
   Prof. Tomaž Kosmač

# RESEARCH PROGRAM

1. Engineering and bio-ceramics
   Prof. Tomaž Kosmač

# NEW CONTRACTS

1. Optimization of ceramics
   Hidria - ip, d. o. o. Tolmin
   Dr. Dakskobler Aleš
2. Research of ceramic glow plug
   Hidria - ip, d. o. o. Tolmin
   Prof. Kosmač Tomaž
3. Research of C/C –SiC ceramic matrix composites for braking systems
   MS Production, Miklavž Zornik, s. p., Bled, Slovenija
   Prof. Kosmač Tomaž

# VISITORS FROM ABROAD

1. M. Sc. Jakub Michalski, Faculty of Materials Science & Engineering, Warsaw University of Technology, Warsaw, Poland, April 3–Aug. 4, 2005.
2. M. Sc. Mariusz Andrzejczuk, Faculty of Materials Science & Engineering, Warsaw University of Technology, Warsaw, Poland, May 3–Nov. 3, 2005.
3. Dr. Hai-Doo Kim, Ceramic Materials Group, Korea Institute of Machinery and Materials, Gyeongnam, Korea; Dr. Hua-Tay Lin, Ceramic Science and Technology Group, Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, USA; Prof. Mike Swain, Biomaterials Unit, Faculty of Dentistry, University of Sydney, Sydney Dental Hospital, Australia, June 19–24, 2005.
4. M. Sc. Alexandra Vysocka, Institute of Materials Research, Slovak Academy of Sciences, Košice, Slovakia, Sept. 15–Dec.15, 2005.

# STAFF

**Researcher**
**1. Prof. Tomaž Kosmač**, Head**
**Postdoctoral associates**
2. Dr. Milan Ambrožič**
3. Dr. Aleš Dakskobler
4. Dr. Kristoffer Krnel**
5. Dr. Jaroslav Slunečko***
6. Dr. Krunoslav Vidović***
**Postgraduates**
7. Sabina Beranič Klopčič, B. Sc.
8. Andraž Kocjan, B. Sc.
**Technical officers**
9. Fedja Marušič
10. Natalija Petkovič
**Technical and administrative staff**
11. Darko Eterović
12. Mojca Hren
13. Tomislav Pustotnik

** Part-time faculty member
*** Member of industrial or other organisation

# DEPARTMENT FOR NANOSTRUCTURED MATERIALS K-7

***The basic and applied research in the department includes ceramic materials, 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 the field of **intermetallic alloys based on RE-TM**, our main scientific contribution was the evaluation of the kinetics of the HDDR process and nitrogenation, which are the two main processes used in the preparation of Sm-Fe-N high-coercivity powders for bonded magnets. The kinetic model for the binary alloy follows the sigmoidal curve of nucleation and the kinetics of the ternary alloys depend only on the amount of unreacted material remaining. With an optimised choice of composition and processing parameters we were able to prepare powders with very high coercivity (Hc=1.6 T). We have also studied the influence of the pulsed-laser deposition processing parameters on the final magnetic properties of nanoscale Sm-Fe-Ta-N films. We have developed a new method for making **thin films of Co-Pt** from a solution of electrolytes by **electrodeposition**. The coercivity that we obtained was 1 T, making the material suitable for use in micro-electro-mechanical systems. One of the highlights of last year was the development of a production process for **ultra-thin 100-μm Nd–Fe–B magnets** with a Hc of 1.3 T using a low-temperature sintering process. In the field of hydrogen-storage materials we have designed and constructed a working hydrogen-storage measuring device, and complemented it with a high-pressure, high-temperature charging device. Experiments were performed on intermetallic alloys like $LaNi_5$, and the results were presented as the interdependence of the equilibrium pressure of hydrogen and the amount of hydrogen in the material ([H]/[M]). Using a mechanical alloying process we prepared **quasicrystals based on the ternary systems Ti-Zr-Ni and Ti-Hf-Ni**. The growth of the icosahedral quasicrystalline phase was followed using X-ray diffraction, vibrating-sample magnetometry and scanning electron microscopy combined with electron diffraction spectroscopy. We have managed to index the main x-ray peaks with the corresponding six Miller indices, which confirm the existence of the **icosahedral structure**.

In the framework of the European fusion programme we continued the development of a **SiC continuous-fibre-based composite** for applications under extreme conditions. We prepared SiC-based samples with nano- and submicron-sized particles and a phosphate-based glassy phase, and analysed the effect of various process parameters on the composition, the porosity, the mechanical properties and the microstructure of the material. **Electrophoretic deposition** was studied as a potential technique for forming SiC-based materials that will enable us to prepare various thick coatings and bulk materials in future work. The microstructure of the SiC-fibre-based composite materials was studied using analytical electron microscopy. In the matrix phase, composed of SiC particles embedded in an Al-Si-P-O glassy phase, the chemical and phase compositions were monitored as a function of the processing parameters. We found that the amount of oxygen in the starting materials is a critical factor. Another investigation in the same system involved a study of the wettability of SiC fibres. Using various tenzides we improved the wettability of the originally hydrophobic SiC fibres.

**The department is collaborating in the European Fusion Programme and playing an active part in establishing the Slovenian Fusion Association, SFA Euratom-MHST, March 2005.**
**Our role in this long-term international programme is to collaborate in the development of advanced materials and technologies. The present research is focused on low-activation SiC/SiC materials for the first wall blanket in a future fusion reactor.**

Research activities on **ZnO-based ceramics** were focused on studies of the influence of very low amounts of dopant, up to several 1000 ppm, on the sintering, grain growth and microstructure development. Cations of the oxides $Bi_2O_3$, $Sb_2O_3$, $Al_2O_3$ and $MnO_2$ were added to the ZnO as aqueous solutions of their salts. The results revealed different grain-growth mechanisms that could be expected in accordance with the type of dopant and its chemistry in ZnO ceramics. This is important for the development of varistor ceramics and also for other applications of ZnO in electronics.

In collaboration with the company VARSI (Ljubljana), miniaturised varistor blocks, with their height reduced by about 25% in comparison to the standard blocks, were developed. The successful realisation of the miniaturised

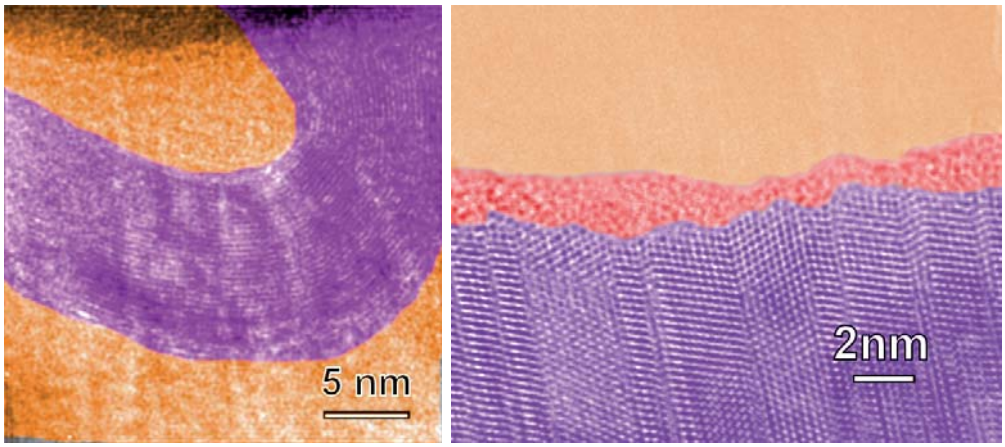


*Figure 1: Nanosized crystalline feature in SiC fiber (left). Thin amorphous $SiO_2$ layer on crystalline SiC particle. (right)*

varistor blocks enabled the company MECOM (Ljubljana) to develop a prototype miniaturised 24-kV arrester. In collaboration with the companies VARSI, ETI and Alfa&Omega a prototype of an integrating varistor, which combines the over-voltage protection of a varistor and the current protection of the classical fuse in one element, was developed.

During our studies of the nucleation and growth of special boundaries in ZnO doped with various additives, we investigated the **mechanisms of inversion-boundary formation**. The basic principle of inversion-boundary formation is based on the compensation of $Zn^{2+}$ vacancies in the ZnO structure. III+ dopants ($In^{3+}$) diffuse into the ZnO crystal along the basal planes, where, triggered by the charge compensation, $Zn^{2+}$ ions are shifted to the inverse sites of the structure. In the case of IV+ ($Sn^{4+}$) and V+ ($Sb^{5+}$) dopants, the diffusion into the ZnO structure does not occur; instead, the dopant ions are located at the octahedral sites of the structure on the surface Zn layers, causing the inversion of the structure during the subsequent growth of the crystal, which contains an inversion boundary.

We have continued our studies of **twinning in minerals** and showed that twin boundaries are chemically triggered in all the investigated crystals. In the case of contact twins in spinel crystals we have shown that the twinning is caused by the presence of beryllium, the iron-cross twins in pyrite are caused by small amounts of copper, the (301) and (101) twins of rutile are formed by an epitaxial growth of rutile domains on the ilmenite and corundum interlayers, respectively, whereas the polytipic sequences in bixbyite crystals are caused by the incorporation of silicon that forms coherent layers of braunite.

We have **developed a new method, called IMAGE-WARP**, which is used for the correction of geometrically-distorted atomically-resolved HAADF-STEM images. The method allows the extraction of up to 99% of the structural-chemical information based on Z-contrast images, compared to conventional FFT methods that restore only up to 67% of the information.

In the area of the development and implementation of atomically resolved HAADF-STEM analysis and the HAADF-STEM code for quantification, we showed, in the case of antiphase boundaries in perovskite ($SrTiO_3$), that the local lattice distortions across the planar faults drastically influence the intensities of atom columns at the faults and within adjacent atom planes in experimental HAADF-STEM images. This observation emphasises the necessity of a new approach to interpreting measured intensities in experimental HAADF-STEM images. The HAADF-STEM was additionally used to determine the thickness and deformation of a crystal lattice of individual GaN and GaAlN layers in a GaN/GaAlN superstructure composed of 200 consecutive GaN and GaAlN layers. In complex ferroelectric materials with a tungsten bronze-type structure we used HAADF-STEM to study the variation of the chemical composition of individual atom columns based on the measured experimental intensities. In $Sr(Ti,Fe)O_3$-based oxygen sensors we determined the structure of the planar faults that form in the material as a consequence of Fe incorporation in the perovskite lattice. In polycrystalline PMN-PT we studied the phenomenon of exaggerated grain growth during sintering, attributing it to variations in the chemical composition of the liquid phase. In doped $Al_2O_3$ ceramics we found that different Y-Al-O precipitates can be formed within $Al_2O_3$ at the same time, which was not observed before. The analytical results obtained with electron-energy-loss spectroscopy showed that $YAlO_3$ (YAP) is the main secondary phase in the system, rather than $Y_3Al_5O_{12}$ (YAG). Since the amount of segregated Y at the grain boundaries depends on the type of precipitate, the variation in precipitate types in $Al_2O_3$ determines the amount of segregated Y at the boundaries, which consequently influences the final mechanical properties of $Y_2O_3$-doped $Al_2O_3$ ceramics.

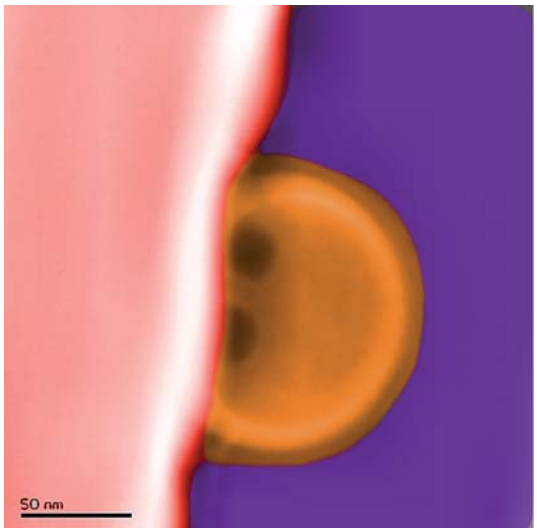


*Figure 2: STEM image of Sm-Fe-Ta-N nanocrystals in a droplet deposited by pulsed laser deposition in nitrogen atmosphere.*

Technologically interesting materials were also investigated using modelling. These studies focused on the field of **magnetism at the nanoscale level**, i.e., thin films and nanowires. We have also begun to model the **disproportionation kinetics** in the Sm-Fe system and study the structural properties of semiconductors, i.e., grain-boundary development in ZnO doped with Sb.

In the frame of our national project "Exploration and preservation of Slovenian mineralogical heritage" we completed several field trips to the Idrija mercury mine and collected samples from the few accessible ore bodies at the 9th and 11th levels of the mine. The samples were used to study the mineral paragenesis and the morphology of minerals that occur in tectonically shattered and richly mineralised zones of the Idrija mine.

Members of the department are, as part of the research and development program, heavily involved in managing and organising the Centre for Electron Microscopy within the frame of the national infrastructure Centre for Microstructural and Surface Analysis. The implementation of various electron microscopy analytical techniques and the access for researchers to electron microscopy research facilities is of utmost importance for numerous research institutions, industrial partners, as well as for graduate- and post-graduate education.

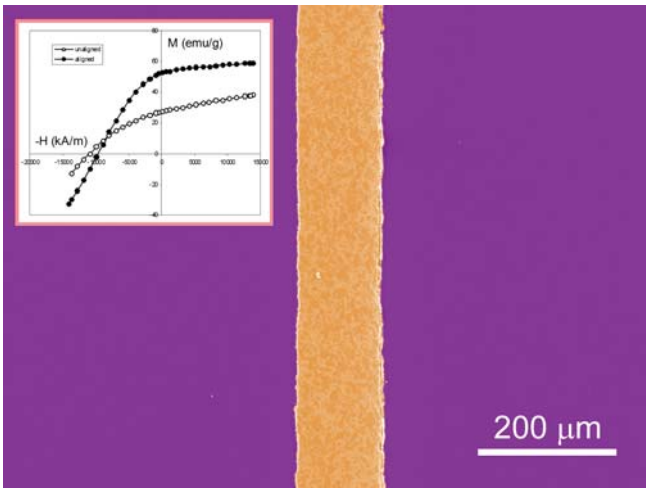


*Figure 3: Nd-Fe-B thick film (Hc= 1,1 T) for MAGMAS application (Magnetic Micro-Actuators & Systems).*

## Some outstanding publications in the year 2005

1. A. Rečnik, G. Möbus, S. Šturm, IMAGE-WARP: A real-space restoration method for high-resolution STEM images using quantitative HRTEM analysis, Ultramicroscopy, 103 (2005), 285-301.
2. K. Žužek Rožman, P.J. McGuiness, M. Komelj, S. Kobe, A kinetic evaluation of the disproportionation reaction in SM-Fe-based materials, J. magn. magn. mater., 290-291 (2005), 1181-1183.
3. M. Komelj, N. Stojič, *Ab- initio* investigation of magnetism in two-dimensional uranium systems, Phys. rev., B, Condens. matter mater. phys., 71 (2005), 052410-1-052410-4.
4. S. Novak, G. Dražič, M. Kalin, Structural changes in $ZrO_2$ ceramics during sliding under various environments, Wear, 259 (2005), 562-568.

## Patent granted

1. Paul J. McGuiness, Gregor Geršak, Spomenka Kobe
   Permeameter for measuring magnetic properties at high temperatures
   International patent, No. WO 2005/040842 A1: Geneva, The International Bureau of WIPO, 2005.

## Awards and appointments

1. Dr. Nina Daneu: Humboldt Research Fellowship, Alexander von Humboldt Foundation, Bonn, Germany, March 23, 2005
2. Dr. Sašo Šturm: "Atomic Resolution HAADF-STEM Imaging and EELS Analysis of Ruddlesden-Popper Faults in the AO-doped $SrTiO_3$ ($A=Sr^{2+}$, $B_2^{2+}$)", Best Early Career Scientist Award, EDGE 2005, International EELS Workshop, Grundlsee, May 1 - 5, 2005
3. Jožef Stefan Institute Roll of Honour for successful scientific and technological cooperation with the Jožef Stefan Institute to VARSI d.o.o., the long-standing partner in the development of ZnO varistors, Ljubljana, June, 2005
4. Benjamin Podmiljšak: "Ultra-Thin Sintered and Bonded Nd-Fe-B Magnets for MEMS Applications". Winning contribution of young scientists at the 13th Conference on Materials and Technologies, Portorož, October 10–12, 2005

## Organization of conferences, congresses and meetings

1. Fusion EXPO, March 21 - 31, 2005, Galery TR3, Ljubljana
2. 7th Multinational Congress on Microscopy – 7MCM, Portorož, June 26 – 30, 2005
3. 13th Conference on Materials and Technology, Portorož, October 10 – 12, 2005 (co-organisation)
4. IX Conference & Exhibition of the European Ceramic Society – ECerS 2005, Portorož, June 19 – 23, 2005 (co-organization of the Symposium Analytical Methods)

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18. Aleksander Rečnik, Günter Möbus, Sašo Šturm: IMAGE-WARP: a real-space restoration method for high-resolution STEM images using quantitative HRTEM analysis. Ultramicroscopy, Vol. 103, 2005.
19. Makoto Shiojiri, Miran Čeh, Sašo Šturm, C. C. Chuo, Jung-Tsung Hsu, Jer-Ren Yang, Hiroshi Saijo: Determination of thickness and lattice distortion for the individual of strained $Al_{0.14}Ga_{0.86}N$/GaN superlattice by high-angle annular dark-field scanning transmission microscopy. Appl. phys. lett., Vol. 87, pp. 031914-1-031914-3, 2005.
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21. Kristina Žužek Rožman, Paul J. McGuiness, Matej Komelj, Spomenka Kobe: A kinetic evaluation of the disproportionation reaction in SM-Fe-based materials: presented at the Joint European Magnetic Symposia (JEMS' 04) September 5-10, 2004, Dresden, Germany. J. magn. magn. mater., Vol. 290-291, pp. 1181-1183, 2005.


## PUBLISHED CONFERENCE PAPERS

### Invited Papers


1. Miran Čeh, Sašo Šturm, Hui Gu, Makoto Shiojiri: HAADF-STEM imaging: from a qualitative to a quaantitative interpretation of atomic-resolution HAADF-STEM images. 8th Inter American Congress on Electron Microscopy, CIASEM 2005: September 25-30, 2005, La Habana, Cuba: proceedings, [S.l.], CIASEM, 2005, 2 pp.
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3. Makoto Shiojiri, Miran Čeh, Hiroshi Saijo: HAADF-STEM imaging and its application to structural and compositional analysis of GaN-based violet laser diodes. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 91-94.
4. Sašo Šturm, C. Koch, Miran Čeh, Elena Tchernychova, Manfred Rühle: Quantitative HRTEM and HAADF-STEM analysis sof Ruddlesden-Popper planar faults in nonstroichiometric $SrTiO_3$. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 59-62.
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### Regular Papers


1. Slavko Bernik: Preliminary study of ZnO-based varistor ceramics doped with $Al_2O_3$. Proceedings, 41th International Conference on Microelectronics, Devices and Materials and the Workshop on Green electronics, September 14–16, 2005, Ribno, Slovenia, Barbara Malič, ed., Darko Belavič, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2005, 6 pp.
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13. J. Jeon, Miran Čeh: Microstructural characterization of PMN-PT monocrystals growns by sintering process from polycrystalline matrix. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 287-288.
14. Matjaž Mazaj, Nataša Zabukovec Logar, Nina Daneu, Nataša Novak Tušar, Maja Mrak, Venčeslav Kaučič: Pore distribution in a microporous/mesoporous materials BEA/MCM-41 studied by HRTEM. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 273-274.
15. Paul J. McGuiness, David Jezeršek, Spomenka Kobe, Boris Saje: 100-[mi]m-thick sintered magnets for MEMS-type applications. Euro PM2005 Congress: October 2–5, 2005, Prague, Czech Republic, [S.l.], EPMA, 2005, pp. 427-432.
16. Witold Mielcarek, Krystyna Prociów, Slavko Bernik: Microstructure homogenization of ZnO-$Bi_2O_3$ ceramics using modified $Bi_2O_3$. MIPRO 2005: 28th international convention, May 30 - June 03, 2005, Opatija, Croatia: proceedings, Petar Biljanović, ed., Karolj Skala, ed., Rijeka, MIPRO, 2005, pp. 37-42.
17. Elisabeth Pesch, Heike Burghardt, Werner Mader, Nina Daneu, Aleksander Rečnik: Distribution of dopant elements in piramidal and basal-plane inversion boundaries in (Sn, Ga)-doped zinc oxide. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 285-286.
18. Angelika Pretorius, Aleksander Rečnik, Roland Kröger: Atomic structure of basal-plane inversion boundaries of pyramidal defects in Mg-doped GaN epitaxial layers. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 311-312.
19. Aleksander Rečnik, Nina Daneu, Slavko Bernik: Quantitative HRTEM analysis of basal-plane inverson boundaries in $SnO_2$-doped zinc oxide. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 271-272.
20. Aleksander Rečnik, Nina Daneu, Hans-Joachim Kleebe, Tadej Dolenec: Electron microscopy study of {100} faults in bixbyite crystals from the Thomasrange rhyolite (Utah). Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 195-196.
21. Zoran Samardžija, Darko Makovec: Quantitative WDXS microanalysis of $Y_2O_3$-doped $BaTiO_3$. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 289-290.
22. Barbara Simončič, Tea Toplišek: Influence of the surfactant structure on the surface free energy of the desized cotton fabric. Proceedings. Book 2, 5th World Textile Conference AUTEX 2005, June 27-29, 2005, Portorož, Slovenia, Alenka Majcen Le Marechal, ed., Maribor, Faculty of Mechanical Engineering, Department of Textiles, 2005, pp. 401-405.
23. Vesna Šrot, M. Rogers, Medeja Gec: TEM sample preparation of sphalerite crystals. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 381-382.
24. Polona Umek, Pavel Cevc, Boštjan Jančar, Adolf Jesih, Miran Čeh, Denis Arčon: Synthesis and characterisation of titania based nanotubes and nanoribbons. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, Jožef Stefan Institute, 2005, pp. 179-180.
25. F. Wetscher, R. Pippan, Sašo Šturm, F. Kauffmann, Christina Scheu, G. Dehm: Microstructiral evolutin of a pearlitic steel during severe plastic deformation. Abstract book, IX. Conference and exhibition of the European Ceramic Society, June 19–23, 2005, [Ljubljana, The Slovenian Ceramic Society], 2005, pp. 187-188.
26. Slavko Bernik, Zoran Samardžija: Vrstična elektronska mikroskopija (SEM) in mikroanaliza. Posvet o meritvah (Conference on Measurements): November 10–11, 2005, Ljubljana, Jožef Stefan Institute, 2005, 2 pp.
27. Miran Čeh: Transmisijska elektronska mikroskopija (TEM, STEM, AEM). Posvet o meritvah (Conference on Measurements): November 10–11, 2005, Ljubljana, Jožef Stefan Institute, 2005, 2 pp.

# THESES

## B. Sc. Theses

1. Katja Mejak: The Effect of the Surface Modification of Alumina Powder on the Rheological Properties of Parafin Suspensions for Low-pressure Injection Moulding (Prof. Andreja Zupančič-Valant, Dr. Saša Novak)
2. Matejka Podlogar: Grain Growth and Microstructure Development in $Sb_2O_3$-Doped ZnO-$Bi_2O_3$ Ceramics (Prof. Tone Meden, Dr. Slavko Bernik)

# INTERNATIONAL PROJECTS

1. Complex Metallic Alloys
   CMA
   6. FP; NMP3-CT-2005-500140
   EC; Centre National de la Recherche Scientifique, Paris, Cedex, France
   Prof. Spomenka Kobe, Prof. Janez Dolinšek, Dr. Peter Panjan
2. Novel Processing of SiC/SiC by Vacuum Slip-Infiltration of SiC Fibre Preforms - UT2 SIC-VSI
   Slovenian Fusion Association EURATOM – MHST
   6. FP, EURATOM, SFA; FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Hihger Education, Science and Technology, Ljubljana, Slovenia
   Dr. Goran Dražič, Dr. Saša Novak Krmpotič
3. Gas Impermeable Coatings for SiC/SiC - UT1
   SICOAT
   Slovenian Fusion Association EURATOM – MHST
   6. FP, EURATOM, SFA; FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Hihger Education, Science and Technology, Ljubljana, Slovenia
   Dr. Saša Novak Krmpotič, Dr. Goran Dražič
4. Strengthening the Role of Women Scientists in Nano-Science
   WOMENINNANO
   6. FP; SAS6, 016754
   EC; Dr. Annett Gebert, IFW Dresden, Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden E.V., Dresden, Germany
   Prof. Spomenka Kobe
5. Increasing the Performance of Total Hip Replacement Prostheses Through Functionally Graded Material Innovation and Design
   BIOGRAD
   5. FP; G5RD-CT-2000-00354
   EC; Prof. Omer Van Der Biest, Katholieke Universiteit Leuven, Departement Metaalkunde en toegepaste materiaalkunde (MTM), Leuven, Belgium
   Dr. Saša Novak Krmpotič
6. A Novel Miniaturised High Voltage Surge Arrester
   VARESTER
   5. FP; G1ST-CT-2002-50263
   EC; Mirjam Cergolj, Varsi, d. o. o., Ljubljana, Slovenia
   Dr. Slavko Bernik
7. Micrometer Scale Patterning of Protein and DNA Chips
   MICROPROTEIN
   5. FP; G5RD-CT-2002-00744
   EC; Dr. Ion Siotis, National Hellenic Research Foundation, Theoretical and Physical Chemistry Institute, Athens, Greece
   Prof. Spomenka Kobe, Dr. Goran Dražič
8. Slovenian Fusion Association EURATOM – MHST, Public Information
   6. FP, EURATOM, SFA; FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Hihger Education, Science and Technology, Ljubljana, Slovenia
   Dr. Saša Novak Krmpotič
9. Energy-Filtered Transmission Electron Microscopy (EF-TEM) and High Resolution Scanning Transmission Electron Microscopy (HR-STEM) of Nanoparticles and Interfaces in Materials
   SI-AT/04-05/019
   Prof. Ferdinand Hofer, Technische Universität Graz, Institut für Elektronenmikroskopie und Feinstrukturforschung, Graz, Austria
   Asst. Prof. Miran Čeh
10. Fuel Storage Nano-Composites Fabricated by Pulse Laser Deposition – PLD
    BI-GR-04-06-019
    Prof. A. C. Cefalas, National Hellenic Research Foundation, Theoretical and Physical Chemistry Institute, Athens, Greece
    Prof. Spomenka Kobe
11. Analysing the Interactions of Rare-Earth Transition-Metal Alloys with Hydrogen and Nitrogen
    BI-HR/04-05-036
    Dr. Muhamed Sućeska, Brodarski Institut, Laboratorij za termičku analizu, Zagreb, Croatia
    Dr. Paul McGuiness, Prof. Spomenka Kobe
12. Precipitation of calcium carbonate in the magnetic field
    BI-HR/05-06-031

Dr. Damir Kralj, Institut Ruđer Bošković, Zagreb, Croatia
Asst. Prof. Spomenka Kobe

13. Controlled Processing of ZnO Based Varistor Ceramics
SLO-JPN
Dr. Toshiyuki Isshiki, Kyoto Institute of Technology, Faculty of Engineering and Design, Dept. Electronics & Information Science, Matsugasaki, Sakyo-ku, Kyoto, Japan
Dr. Nina Daneu
14. IMAGE-WARP: Processing of Atomic-Resolution HAADF-STEM Images
SLO-JPN
Dr. Hiroshi Saijo, Kyoto Institute of Technology, Faculty of Engineering and Design, Dept. Electronics & Information Science, Matsugasaki, Sakyo-ku, Kyoto, Japan
Dr. Aleksander Rečnik
15. Electronic Ceramics with Interface Control of Electrical Properties
BI-CN/06-07/06
Prof. Hui Gu, Shanghai Institute of Ceramics, Shanghai, PR China
Asst. Prof. Miran Čeh
16. Enviromental Hydrogen-based Recycling of Nd-Fe-B Magnets
BI-CN/06-07/08
Dr. Gaolin Yan, Harbin Institute of Technology, ShenZhen Graduate School, HIT Campus of ShenZhen University Town, XiLi, ShenZhen, PR China
Dr. Paul McGuiness
17. Sub-nano Analytical Electron Microscopy of Interfaces and Planar Faults in Ceramic Materials
BI-CN/03-04-017
Prof. Hui Gu, Shanghai Institute of Ceramics, Shanghai, PR China
Asst. Prof. Miran Čeh
18. Microstructural Analysis of Perovskite-Based Electroceramic Materials
U3-MM/K7
Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials (KIMM), Ceramic Materials Group, Sangnam-Dong, Changwon, Korea
Asst. Prof. Miran Čeh
19. Interface Analysis of Piezoelectric Ceramic Materials
U3-MM/K7-05-015
Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials (KIMM), Ceramic Materials Group, Sangnam-Dong, Changwon, Korea
Asst. Prof. Miran Čeh
20. Novel Possibilities for the Processing of ZnO - Based Varistor Ceramics
BI-PL/04-05-009
Dr. Witold Mielcarek, Instytut elektrotechniki - IEL, Wrocław, Poland
Dr. Bernik Slavko
21. Orientation Imaging Microscopy and Microanalysis Applied to Advanced Materials
BI-PL/04-05-010
Dr. Marek Faryna, Polish Academy of Sciences, Institute of Metallurgy and Materials Science, Krakow, Poland
Dr. Dražič Goran
22. Improved Materials Processing Through Tailoring the Surface Characteristics of Nano- and Micro-Sized Powders
BI-PT-04-06-016
Prof. Jose Maria Fereirra, University of Aveiro, Department of Ceramics and Glass Engineering, Aveiro, Portugal
Dr. Saša Novak Krmpotič
23. Development of varistor ceramics with reduced amount of dopants and improved microstructural and electrical characteristics
BI-SCG/05-06-009
Dr. Zorica Branković, Centar za multidisciplinarne studije, Univerzitet u Beogradu, Belgrade, Serbia and Montenegro
Dr. Slavko Bernik
24. Development of Single Crystalline and Electroceramic Materials by Sintering Process
Prof. Mehmet Ali Gülgün, Sabanci Üniversitesi Mühendislik ve Doga Bilimleri Fakültesi, Orhanli Tuzla, Instanbul, Turkey
Asst. Prof. Miran Čeh
25. Texturing and Characterisation of ZnO-based Ceramics
Prof. Ender Suvaci, Anadolu University, Department of Materials Science and Engineering, Eskisehir, Turkey
Dr. Slavko Bernik
26. A Hydrogen-Storage Device for Low-Cost, Environmentally Friendly Transportation
PSP 10/2005
Prof. IR Harris, The University of Birmingham, School of Metallurgy and Materials, Birmingham, Great Britain
Asst. Prof. Spomenka Kobe, Dr. Paul McGuiness
27. Investigations of Twinning and Epitaxial Growth in Minerals
BI-US/04-05/5
Dr. Hans-Joachim Kleebe, Colorado School of Mines, Metallurgical and Materials Engineering Dept., Golden, Colorado, USA
Dr. Aleksander Rečnik
28. Electron Probe Microanalysis of Ceramic Materials – III
BI-US/04-05/30
Dr. Ryna B. Marinenko, National Institute of Standards and Technology (NIST), Chemical Science and Technology Laboratory, Surface and Microanalysis Science Division, Gaithersburg, MD, USA
Dr. Slavko Bernik

# R & D GRANTS AND CONTRACTS

1. Layered ceramic nanostructures and 2D nanoparticles arrays
Asst. Prof. Miran Čeh
2. Nanostructural investigations of special boundaries in minerals
Dr. Nina Daneu, Prof. Tadej Dolenec
3. Qualitative Z-contrast microscopy of functional ceramics
Asst. Prof. Spomenka Kobe, Dr. Sašo Šturm
4. Exploration and preservation of Slovenian mineralogical heritage
Dr. Aleksander Rečnik
5. Application of new technologies to prevent scaling in industrial flow systems
Prof. Spomenka Kobe
6. Rare-earth-transition-metal alloys for high-energy permanent magnets and metal-hydride batteries
Dr. Paul John McGuiness
7. Development of tissue engineered bone for use in periodontology, traumatology and orthopaedic surgery
Asst. Prof. Miran Čeh
8. Development of Graetzl-type photo-electrochemical cells
Dr. Goran Dražič
9. Magnetic materials and intermetallic alloys (CoE Materials for electronics of next generation and other emerging technologies)
Prof. Spomenka Kobe
10. New generation of elements and devices for protection against transient surges (CoE Materials for electronics of next generation and other emerging technologies)
Dr. Slavko Bernik
11. Characterization on the nanometric scale (CoE Nanosciences and nanotechnologies)
Asst. Prof. Miran Čeh
12. Nanostructured surfaces and interfaces (CoE Nanosciences and nanotechnologies)
Dr. Goran Dražič
13. Fabrication of novel thin films by pulser-laser ablation with in situ ICP-MS analysis of target plumes for deposition control
Prof. Spomenka Kobe
14. Nanostructural engineering of semiconducting materials
Dr. Aleksander Rečnik
15. A development of low-activation material for the first wall in fusion reactor
Dr. Saša Novak Krmpotič
16. Hard magnetic Co-Pt thin films produced with electrodeposition
Prof. Spomenka Kobe, Dr. Kristina Žužek Rožman
17. Research of degradation mechanisms and improvement of properties of metallized film capacitors
Asst. Prof. Miran Čeh

# RESEARCH PROGRAM

1. Nanostructured materials
Prof. Spomenka Kobe

# NEW CONTRACTS

1. Rare-earth-transition-metal alloys for high-energy permanent magnets and metal-hydride batteries
Magneti, d. d., Ljubljana
Dr. Paul McGuiness
2. Application of new technologies to prevent scaling in industrial flow systems
Termoelektrarna-Toplarna, Ljubljana
Prof. Spomenka Kobe
3. Dual energy varistor for impulse currents
Varsi, d. o. o.
Dr. Slavko Bernik

# VISITORS FROM ABROAD

1. Igor Đerđ and Mirjana Bijelić, Faculty of Science, University of Zagreb, Zagreb, Croatia, February 17–18, 2005
2. Dr. Ove T. Aanensen and Dag A. Valand, WaveTech A/S, Kristiansand, Norway, March 1, 2005
3. Dr. George Vekinis, National Centre for Scientific Research "Demokritos" – NCSR, Athens, Greece, March 24–27, 2005
4. Dr. Damir Kralj and Prof. Ljerka Brečević, Inštitut Rudjer Bošković, Zagreb, Croatia, March 24, 2005
5. Jua-juan Xing, Shanghai Institute of Ceramics, Shanghai, China, April 4–June 15, 2005
6. Dr. Witold Mielcarek and Dr. Krystyna Prociow, Elektrotecnical Institute Wrocław, Wrocław, Poland, May 29–June 1, 2005
7. Dr. Ryna Marinenko, National Institute for Standards and Technology, Gaithersburg, USA, May 30–June 2, 2005
8. Dr. Hans Joachim Kleebe, Colorado School of Mines, Denver, USA, June 12–July 3, 2005
9. Dr. Igor Đerđ, Faculty of Science, University of Zagreb, Zagreb, Croatia, June 7, 2005
10. Dr. Goran Branković, Milica Počuća (June 19–July 1, 2005) and Milan Žunić (June 19–July 15 2005), Center for Multidisciplinary Studies of the Belgrade University, Serbia and Montenegro
11. Prof. Jose Maria Ferreira, Universidade de Aveiro, Aveiro, Portugal, June 18–25, 2005
12. Prof. Makoto Shiojiri, Kyoto Institute of Technology, Kyoto, Japan, June 30–July 2, 2005
13. Dr. Marek Faryna, Institute of Metallurgy and Materials Science, Polish Academy of Science, Krakow, Poland, July 3–4 2005
14. Nobuto Naranishi, Hashimoto Laboratory, Tokyo University of Science, Tokyo, Japan, July 1–4, 2005
15. Eng. Stavros Chalkiadakis, National Helenic Research Foundation – NHRF, Athens, July 3–10, 2005
16. Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials – KIMM, Changwon-city, Kyeongnam, Korea, July 18–August 29, 2005
17. Prof. Helmut Clemens and Dr. Christina Scheu, Montan Universität Leoben, Leoben, Austria, August 3, 2005
18. Dr. George Vekinis, National Centre for Scientific Research "Demokritos" – NCSR, Athens, Greece, October 8–15, 2005
19. Dr. Marek Faryna, Institute of Metallurgy and Materials Science, Polish Academy of Science, Krakow, Poland, October 6–12, 2005
20. Prof. Constaninos Cefalas, National Hellenic Research Foundation - NHRF, Theoretical and Physical Chemistry Institute, Athens, Greece, October 8–13, 2005
21. Dr. Damir Kralj, Inštitut Rudjer Bošković, Zagreb, Croatia, October 10–12, 2005
22. Dr. Maša Rajić Linarić, Brodarski Institute, Zagreb, Croatia, October 9–12, 2005

# STAFF

**Researchers**

1. Dr. Slavko Bernik**
2. Asst. Prof. Miran Čeh**
3. Dr. Goran Dražić**
4. **Prof. Spomenka Kobe**, Head**
5. Dr. Matej Komelj**
6. Dr. Paul John McGuiness
7. Dr. Saša Novak Krmpotič
8. Dr. Aleksander Rečnik**

**Postdoctoral associates**

9. Dr. Nina Daneu
10. Dr. Vesna Šrot
11. Dr. Sašo Šturm
12. Dr. Kristina Žužek Rožman

**Postgraduates**

13. Andraž Kocjan, B. Sc.
14. Katja Mejak, B. Sc.
15. Tea Toplišek, B. Sc.

**Technical officers**

16. Sanja Fidler, B. Sc.
17. Medeja Gec, B. Sc.
18. Benjamin Podmiljšak, B. Sc.
19. Zoran Samardžija, B. Sc.

** Part-time faculty member

# DEPARTMENT FOR ADVANCED MATERIALS K-9

***During the investigation of magnetic materials special care was devoted to the study of microwave materials based on hexaferrites. These materials are currently of great interest as prospective magnetic materials for use in microwave techniques and are suitable for devices and absorbers in the millimetre range. In 2005 we continued with the study of low-temperature synthesis of M-type hexaferrites ($BaFe_{12}O_{19}$) from ethyl alcohol solutions by coprecipitation. A mechanism of its formation was proposed and applied to $Co_2Y$ ($Ba_2Co_2Fe_{12}O_{22}$). The formation temperatures of both hexaferrites were lowered by several hundreds degrees Celsius when compared to solid-state synthesis, and by 100-200°C when compared to conventional coprecipitation from water solutions. In addition, W-type hexaferrites, suitable applications in the 20-30 GHz frequency range, were investigated. Synthesis of single-phase W-hexaferrites is a challenging task. The Pechini method was successfully modified for the synthesis of the single-phase $BaNiZnFe_{16}O_{27}$W-hexaferrite.***

Head:
***Prof. Danilo Suvorov***

The work on ferrofluids includes synthesis of magnetic nanoparticles. These were synthesised mostly using coprecipitation from reverse micelles. Spinel ferrites and hexaferrites were synthesised. One of the important research activities this year was on the adaptation of carrier liquids in ferrofluids. In particular, the final magnetization of the ferrofluids, and their stability and viscosity, were the key research parameters. The final aims in this area were the stabilisation of the magnetic particles with oleinic acid and to investigate the influence of various dispersants and carrier liquids on the stability of ferrofluids.

Control of the nanoparticles' size using microemulsion synthesis enabled the systematic study of the adaptation of their crystalline structure to their small (nano) size. A combination of Roentgen absorption techniques (EXAFS, XANES) with electron microscopy and magnetic measurements has been used to follow the distribution of individual cations in the spinel structure of $ZnFe_2O_4$ and $MnZnFe_2O_4$ nanoparticles as a function of their size. $ZnFe_2O_4$, which displays a normal spinel structure as ceramic material, shows, as nanoparticles, a significant inversion of the spinel structure. The flexibility of the $ZnFe_2O_4$ nanoparticle structure is related to the flexibility in their composition – their composition can be changed over a broad range without losing their single-phase spinel structure.

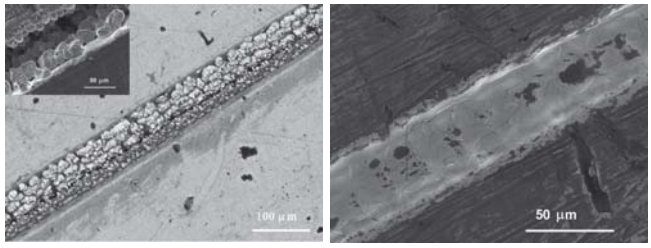


*Figure 1: A new technique of direct laser writing based on photo-reduction of metal ions with laser irradiation: a) photo-reduction of silver ions in an AgCl monocrystal at higher total-energy dose of UV light where ablation of the material appears and b) photo-reduction of silver ions in an AgCl monocrystal at lower total energy dose of UV light with no ablation of the material.*

We continued with the research of lanthanum-strontium manganates. The main purpose of this work is the possibility of using these materials for hyperthermia. The Curie temperature of the manganates can be changed via their chemical composition. For use in hyperthermia a composition which assures a Curie temperature close to body temperature, i.e., around 39°C, is desirable. Silica-coated lanthanum-strontium manganite core-shell particles, with desirable Curie points, and with significant potential in advanced medicine (hyperthermia treatments), have also been prepared. Characterisation and further optimisation of the synthesis parameters is currently taking place. The lanthanum-strontium manganite nanoparticles were covered with a silica layer of thickness 20 nm. This inert silica layer modifies the Curie temperature and chemically isolates the nanoparticle against the influence of reactive body fluids.

In the area of semiconducting ceramics based on high temperature ferroelectrics,e.g. $BaNb_2O_6$, $KNbO_3$ niobates and $KNbO_3$–$BaTiO_3$ solid solutions, we investigated the anomaly in the electric resistivity of high temperature ferroelectrics. Using the Hywang model we developed the material showing the anomaly in the electric resistance in high temperature $BaNb_2O_6$ ferroelectrics . We investigated the sintering of submicron powders of $KNbO_3$ and $KNbO_3$–$BaTiO_3$ solid solutions. With SEM and XRD we analysed the course of the crystallization of the sol-gel-prepared $KNbO_3$. The purpose of this work was to introduce lead-free high temperature posistors which might replace the lead containing posistors in current use.

In the Inorganic Materials and Nanotechnologies research group most investigations were dedicated to fundamental studies of technologically-important dielectrics, such as $La_{2/3}TiO_3$, Bi-titanate pyrochlors, sillenite thin films, and compounds from various multicomponent ceramic systems based on $Bi_2O_3$.

In investigations of the stabilization mechanism of perovskite $La_{2/3}TiO_3$ compounds, unstable due to A-site vacancies, we confirmed that the addition of CaO stabilises the $La_{2/3}TiO_3$ perovskite. Further research was focused on phase equilibria investigations of the ternary $La_2O_3$-$TiO_2$-CaO system at 1350°C. Measurements of the dielectric properties of selected samples showed that ceramics based on $La_{2/3}TiO_3$ – $CaTiO_3$ solid solutions exhibited interesting dielectric properties.

In 2005 we investigated the synthesis of the tetragonal $Bi_{3-y}Nb_{1+y}O_{7+y}$ ($0.2 \leq y \leq 0.04$) solid solution with the fluorite structure because of possible technological applications. This study is in fact the continuation of a previous study on a $Bi_2O_3$-$Nb_2O_5$ system in which we determined that, in the concentration range from 20 to 26 - mol% $Nb_2O_5$, two modifications (cubic and tetragonal) of the fluorite structure are stable at different temperatures. For synthesis optimisation of the tetragonal phase, the reaction mechanism and the tetragonal phase kinetics were determined. Based on the similar ionic radius and chemical character of Nb and Ta we began investigations of the $Bi_2O_3$-$Nb_{2-x}Ta_xO_5$ system, for $0 \leq x \leq 1$. Results showed that high-temperature and metastable-tetragonal fluorite structure of a $Bi_3NbO_7$ is possible also with Ta as a substituent. Measurements in the microwave frequency range showed different properties for cubic and tetragonal phases. Phase transformations between the two modifications most obviously affect the Qxf factor. We also measured positive values of the resonant frequency temperature coefficients for the tetragonal samples, which are interesting for possible applications in low-temperature co-fired-ceramic (LTCC) technology.

Low permittivity substrate materials, which are used in LTCC technology, consist of recrystallized compounds with the general formula $MAl_2Si_2O_8$ (M=Ca, Sr, Ba). $MAl_2Si_2O_8$ belongs to the feldspar structural family with the general formula $MT_4O_8$. Due to their low permittivity and low dielectric loss, the feldspars are also interesting as dielectrics for high frequency applications. ( > 10 GHz) such as satellite communications. Low dielectric losses (Qxf=5000-100000 GHz) were the main reason for the systematic study of the influence of M and T (tetrahedral) cation substitution on the structure and indirectly on the dielectric properties of feldspars. Basic ionic properties (ionic size, dielectric polarisability) have great influence on their structure and indirectly on their dielectric properties. The difference in the ionic size of the M cation (Ca, Sr, Ba) causes the change from the triclinic crystal structure ($\bar{1}$S.G.: *P*1, *I*1) of $CaAl_2Si_2O_8$ to the monoclinic crystal structure (S.G.: I2/c) of $SrAl_2Si_2O_8$ and $BaAl_2Si_2O_8$. The type of M cation has great influence on dielectric losses in the microwave frequency range, while the permittivity was measured between 6 and 8 for all feldspars. Our studies revealed that the $MAl_2Si_2O_8$ feldspars ($CaAl_2Si_2O_8$, $BaAl_2Si_2O_8$) exhibit considerably lower dielectric losses (higher Qxf values) compared to commercial LTCC substrates, where $BaAl_2Si_2O_8$, $SrAl_2Si_2O_8$ and $CaAl_2Si_2O_8$ are formed by recrystallization at the temperature of LTCC technology (900°C). Since the kinetics of the tetrahedral (Al, Si) ordering is sluggish, the $MAl_2Si_2O_8$ feldspars exhibited high Qxf values after prolonged heat-treatment at 1400-1500°C. Slow ordering kinetics are the consequence of the strong Si-O bond. It is known that the $MAl_2Si_2O_8$ feldspars exhibit an order-disorder transition above their melting point, which is considerably higher than the sintering temperature in LTCC technology. The substitution of the tetrahedral ion Al with Ga and Si with Ge causes the lowering of sintering temperature by 200-400°C. Due to the weaker Ge-O bond compared to the Si-O bond the ordering of Ge-feldspars was faster and took place at lower temperatures. Analogous to the $Na_xCa_{1-x}Al_{2-x}Si_{2+x}O_8$ solid solubility between $NaAlSi_3O_8$ and $CaAl_2Si_2O_8$, solid solubility between $KGaGe_3O_8$ and $BaGa_2Ge_2O_8$ can be expected. However, the existence of $K_xBa_{1-x}Ga_{2-x}Ge_{2+x}O_8$ solid solubility had not been reported, yet. We confirmed the existence of this solid solubility and found that: *i.)* the sintering temperature decreased with the increase in K content from $BaGa_2Ge_2O_8$ (x=0), which sintered at 1100°C, to $KGaGe_3O_8$ (x=1), which sintered at 960°C, *ii.)* the temperature of the order-disorder phase transition ($P2_1/a$-C2/m) also decreased with increase in K content, and *iii.)* $K_xBa_{1-x}Ga_{2-x}Ge_{2+x}O_8$ solid solutions also exhibited high Qxf values ($Qxf(K_{0.67}Ba_{0.33}Ga_{1.33}Ge_{2.67}O_8)$=95000 GHz.)

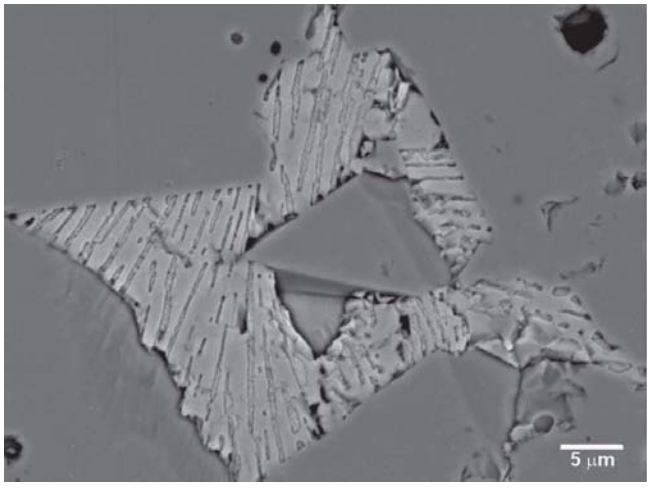


*Figure 2: A grain of $Ba_2ZnWO_6$ double perovskite surrounded by crystallised $Ba_2WO_5$/BaWO4 eutectic liquid that forms as a result of ZnO sublimation.*

The stoichiometric bismuth titanate pyrochlore $Bi_2Ti_2O_7$ produced by the co-precipitation method is only stable at low temperatures, i.e., below 470°C. However, the bismuth-deficient pyrochlores show higher temperature stability: they decompose above 650°C. In addition, some investigations show that it is possible to stabilise bismuth titanate pyrochlore using various dopants. From results obtained on stabilized bismuth titanate pyrochlores with *i)* $Y_2O_3$ and *ii)* $Nd_2O_3$ dopants, prepared with solid state synthesis, we observed the formation of two pyrochlore solid solutions. The compositional range of pyrochlore solid solutions can be described with the following chemical

formulas: *i)* $Bi_{(1.57-x)}Nd_xTi_2O_{6.4}$ (0,25<x<0,97) and *ii)* $Bi_{(1.6-0.8x)}Y_xTi_2O_{(6.4+0.3x)}$ (0,04<x<2). Further extrapolation of x to 0 in both cases indicates that the most likely formation of stable un-doped bismuth titanate pyrochlore would be in a compositional range around $Bi_{1.6}Ti_2O_{6.4}$.

In the scope of the research on double perovskites suitable for microwave applications we investigated phase relations in the BaO-ZnO-$WO_3$ system. Furthermore we determined an influence of the firing atmosphere on the rate of ZnO sublimation from $Ba_2ZnWO_6$ perovskite. We established that firing in an increased oxygen partial pressure or ZnO muffling, tends to retard the sublimation, but also causes the formation of ZnO inclusions in the perovskite ceramic microstructure. Further investigations involved a study of the decomposition mechanism of $Ba_2ZnWO_6$ which occurs as a consequence of ZnO sublimation. We found that, at first, perovskite decomposes to crystalline $BaWO_4$ and amorphous BaO which then subsequently react to give crystalline $Ba_2WO_5$. In the case of solid solutions between $Ba_2ZnWO_6$ and $Ba_3ZnNb_2O_9$, sublimation of ZnO results in the formation of $Ba_3W_{1.33}Nb_{0.66}O_{8.66}$, a hexagonal perovskite with cation vacancies. We therefore extended our research of microwave dielectrics with a study of perovskite hexagonal polymorphs.

In the past year we also investigated the pseudo-ternary $Bi_2O_3$-$TiO_2$-$TeO_2$ system, synthesised in atmospheres with high oxygen partial pressures. It was discovered that, by the use of the solid-state reaction technique, three new ternary compounds can be synthesised, all including $Te^{6+}$. In collaboration with the JSI and the Faculty of Chemistry and Chemical Engineering, University of Ljubljana, the crystal structures of the new compounds $Bi_2Ti_3TeO_{12}$, $Bi_2TiTeO_8$ and $Bi_6Ti_5TeO_{22}$ were determined. By densification of single-phase powders in an oxygen atmosphere the thermal decomposition processes related to the evaporation of $TeO_2$ or/and release of oxygen can be detected . These decomposition processes can be partially hindered by the use of an increased oxygen partial pressure during firing. For example, by firing the $Bi_2TiTeO_8$ samples in an autoclave furnace at 10 bar of oxygen partial pressure, the decomposition processes can be shifted towards higher temperatures by 50ŞC. Such an increase of the decomposition temperature improves densification of the powders and allows determination of the dielectric properties. Sintered $Bi_2Ti_3TeO_{12}$ ($Bi_2TiTeO_8$) ceramics exhibits a relative permittivity of 45 (35) and Q×f values of 11 200 GHz (5 600 GHz). Among all of the newly discovered compounds, the most interesting dielectric properties are exhibited by $Bi_6Ti_5TeO_{22}$ ceramics with a relative permittivity, measured at 1MHz of 350 and dielectric losses of tan $\delta < 10^{-4}$.

A significant part of our work was devoted to new research activities. For example, we investigated a direct laser writing technique based on the reduction of metal ions by laser irradiation. Applications envisaged for direct laser writing in modern technology are in LTCC technology, metamaterials synthesis, prototype production of fine-scale electronic circuitry (CAD supported) and stereo lithography.

In the field of biomimetic materials we successfully prepared nano-sized $CaCO_3$ particles, containing small amounts (few %) of $MgCO_3$. We d also developed a high-temperature reaction method for the synthesis of super-hard materials based on $MgAlB_{14}$, with reaction yields > 90%.

**The diameter of chrysotile nanotubes can be controlled by varying the hydrothermal-reaction temperature, which controls the number Mg-Si bilayers stacked together in the direction normal to the (001) basal plane of the pseudo-hexagonal structure prior to the commencement of curling.**

Research on 1D nanostructures based on the investigation of the growth mechanism of chrysotile nanotubular crystals under hydrothermal conditions, was carried out. We established that these nanotubes form by the curling of Mg-Si bilayers, formed by a hydrothermal reaction, after a threshold nanocrystal size has been exceeded. The nanotubes formed grow along the axis of curling while their diameter remains constant. The diameter can be controlled by the reaction temperature. An increase in temperature yields thicker tubes. Furthermore, we expanded our studies of nanostructures with an investigation into the possibility of synthesising semiconducting SnO-based nanotubes under hydrothermal conditions.

In the field of glass research we focused our investigations on research for foreign (Heraklith, Paroc, Gamma Meccanica) and domestic (TERMO) companies. These investigations included chemical analysis of several raw materials for mineral fibre production, analysis of raw material melting, and analysis of unmelted inclusions. The final goal of these studies was to provide consultaion advice to the industrial partners for proper raw materials selection. The viscosities of glass melts and their electro-conductivities were also determined. Based on this information we prepared several bio-soluble mineral fibres on a semi-industrial scale. We also investigated, for industrial partners, the influence of increased humidity and temperature on the binding of organic pastes needed for manufacturing mineral-wool-based products.

For the Glass factory Rogaška we performed extensive studies of defects with a special focus on their nature and their formation stage in the production line. This was undertaken with the purpose of enabling technologists to direct the process of glass production in a way that would prevent the appearance of inclusions. We found that most of the inclusions in glass from the Glass factory Rogaška appear as a result of corrosion of the refractory materials, large-grained and contaminated raw materials, as well as unsuitable thermal conditions. However, most frequently, inclusions originate from the refractory materials at the glass-contact area of the furnace, where fused

cast AZS and zircon refractories are used. Using these results, special corrective actions, such as recovering the furnace temperature, or replacing the damaged refractory material, were put into place to avoid the occurrence of defects in glass products.

As a part of our industrial cooperation with EPCOS OHG from Deutschlandsberg, Austria, we launched the prototype production of a new material developed in our laboratories. After K 80 material was successfully introduced in production in 2004, we developed K35 material which passed all the tests for pilot production. In addition, a new K<20 material was developed in the laboratory.

## Some outstanding publications in the year 2005

1. Irena Pribošič, Darko Makovec, Mihael Drofenik, Chemical synthesis of $KNbO_3$ and $KNbO_3$-$BaTiO_3$ ceramics. J. Eur. Ceram. Soc., 2005, Vol. 25, pp.2713-1717.
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5. Matjaž Valant, Danilo Suvorov, Christian Hoffmann, Helmut Sommariva, Method for producing a ceramic silver niobium tantalate body : United States Patent No. US 6,843,956 B2., 2005

## Patents granted

1. Christian Hoffmann, Helmut Sommariva, Danilo Suvorov, Matjaž Valant
   Multilayer ceramic capacitors from dielectric ceramics based on silver tantalum and niobium
   Patent no. DE 10042359.0
2. Christian Hoffmann, Danilo Suvorov, Matjaž Valant
   Dielectric ceramic materials
   Patent no. US 6956001 B2, 2005
3. Matjaž Valant, Danilo Suvorov, Christian Hoffmann, Helmut Sommariva
   Method for producing a ceramic silver niobium tantalate body
   Patent no. US 6,843,956 B2
4. Matjaž Valant, Danilo Suvorov
   Low sinterable ceramics based on $Li_2O$-doped $(Ba,Sr)TiO_3$
   Patent no. 21516

## Awards and appointments

1. Špela Kunej: 1st Award, Student Poster Competition, IX European Ceramic Society Conference and Exhibition, Portorož, 19. 6. - 23. 6. 2005
2. Sašo Gyergyek: Henkel Fund Reward for B. Sc. Thesis, Maribor, Henkel Fund, "Synthesis of some copper (II) metanoates with aminopyridine", 23. 12. 2005

## Organization of conferences, congresses and meetings

1. 5. Framework Meeting "TUF Tuneable Filters Based on Dielectric Resonators", Ljubljana, 9. 3. - 12. 3. 2005.
2. 107th Annual Meeting and Exposition of American Ceramic Society, Baltimore, USA, 10. 4. 2005 - 14. 4. 2005 (co-organization)
3. IX European Ceramic Society Conference and Exhibition, Portorož, Slovenia, 19. 6. - 23. 6. 2005
4. 13th Conference on Materials and Technology, 10. 10. - 12. 10. 2005, Portorož, Slovenia (co-organization)

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### Invited Paper


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17. Polona Umek, Pavel Cevc, Boštjan Jančar, Adolf Jesih, Miran Čeh, Denis Arčon: Synthesis and characterisation of titania based nanotubes and nanoribbons. Proceedings, 7th Multinational Congress on Microscopy, June 26-30, 2005, Portorož, Slovenia, Miran Čeh, ed., Goran Dražić, ed., Sanja Fidler, ed., Ljubljana, Slovene Society for Microscopy, Department for Nanostructured Materials, "Jožef Stefan" Institute, 2005, pp. 179-180.
18. Andrej Žnidaršič, Vladimir Boštjan Bregar, Darja Lisjak, Mihael Drofenik: Ceramic composites for EMI supression in UHF frequency range. Ninth International Conference on Ferrites (ICF-9): proceedings of the International Conference on Ferrites (ICF-9), San Francisco, California (2004), Ronald F. Soohoo, ed., Westerville, The American Ceramic Society, 2005, pp. 489-496.
19. Andrej Žnidaršič, Vladimir Boštjan Bregar, Bogo Miklavčič: Film absorber materials for reduction of electromagnetic noise. Power electronics technology: exhibition & conference: October 25027, 2005, Baltimore Convention Center, Baltimore, MD, [S.l., s.n.], 2005, 7 pp.
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## THESES

### B. Sc. Theses

1. Stanislav Čampelj: Fuel cell anode material testing (Prof. Jadran Maček)
2. Sašo Gyergyek: Synthesis of some copper (II) metanoates with aminopyridine (Prof. Mihael Drofenik)
3. Janez Virc: Glass fibres for thermal insulation (Prof. Danilo Suvorov)

## PATENT APPLICATIONS

1. Andrej Žnidaršič, Vladimir Boštjan Bregar, Nevenka Rajnar
   Sheet absorbers of electromagnetic waves with frequency range up to 12 GHz
   Patent application no. 200500115
2. Andrej Žnidaršič, Darja Lisjak, Vladimir Boštjan Bregar, Mihael Drofenik, Nevenka Rajnar
   Ceramic ferrite materials for absorption of electromagnetic waves in frequency range from 100 MHz to 12 GHz
   Patent application no. 200500035

## INTERNATIONAL PROJECTS

1. Tuneable Filters based Dielectric Resonators
   TUF
   5. FP; G1RD-CT-2002-00741
   NPL Management Ltd., Teddington, Great Britain
   Prof. Danilo Suvorov
2. Advanced Electronic Ceramics (Grain Boundary Engineering)
   COST 525
   EC; Prof. Robert Freer, University of Manchaster and UMIST, Manchaster Materials Science Centre, Manchaster, Great Britain
   Prof. Danilo Suvorov, Co-chair
   Subprojects COST 525:
   - Microstructure, Grain Boundaries and Electrical Properties of Donor/Acceptor Co-doped $BaTiO_3$-Based Ceramics
     Prof. Danilo Suvorov
   - Grain Boundary Engineering in $BaTiO_3$ Ceramics
     Asst. Prof. Darko Makovec
   - Microwave Dielectric Loss Mechanisms in New Microwave Ceramics
     Asst. Prof. Matjaž Valant
3. Materials for LTCC Applications made by Electo-phoretic Deposition
   EUREKA, LOFT-CFC; 400-65/2004
   Dr. Marjeta Maček-Kržmanc
4. Ferrite Materials and Nonreciprocal Devices for Mm-wave Applications
   EUREKA, FDMA
   E!3451, 400-76/2004-2
   Dr. Darja Lisjak
5. Investigation of Materials and Processes in MLC Manufacturing
   No. N70/04
   Dr. Klauss Reichmann, EPCOS OHG, Deutschlandsberg, Austria
   Prof. Danilo Suvorov
6. Investigation of Materials and Processes in MLC Manufacturing
   Raziskovalno razvojna naloga, N0083/05
   Dr. Klauss Reichmann, EPCOS OHG, Deutschlandsberg, Austria
   Prof. Danilo Suvorov
7. Characterization of Bio Soluble Mineral Fibres
   No. N95/04
   Ingram Eusch, Heraklith AG, Ferndorf, Austria
   Prof. Danilo Suvorov
8. LTCC Materials for Microwave Applications
   No. N0089/04
   Dr. Christian Hoffmann, EPCOS OHG, Deutschlandsberg, Austria
   Dr. Boštjan Jančar
9. Characterization of the Materials for Bio Soluble Mineral Fibres Production
   No. N30/05
   Dr. Michael Perander, Paroc Group OY AB, Pargas, Finland
   Prof. Danilo Suvorov
10. Synthesis and Characterization of Magnetic Nanoparticles
    PROTEUS
    Prof. Jean-Luc Rehspringer, Groupe des ateriaux inorganiques, Institut de Physique et Chimie des Materiaux, Strasbourg, France
    Asst. Prof. Darko Makovec
11. New Glass Materials based on Tellurium Oxide for Non-linear Optics
    PROTEUS
    Prof. Phillipe Thomas, UMR 6638 CNRS, Faculte des Sciences, Science des Procedes Ceramiques et de Traitements de Surface, Limoges, France
    Asst. Prof. Matjaž Valant, Dr. Marko Udovič
12. The Role of Enzymes in Formation of Colloidal Particles
    BI-HR/04-05-026
    Dr. Ivan Sondi, Institut "Ruđer Bošković", Zagreb, Croatia
    Dr. Srečo Davor Škapin
13. Characterization of the Materials for Mineral Fibres Production
    Raziskovalno-razvojna naloga, N0077/04
    Giovanni Burini, Gamma Meccanica, Bibbiano, Reggio Emilia, Italy
    Prof. Danilo Suvorov
14. Characterization of the Materials for Mineral Fibres Production
    Giovanni Burini, Gamma Meccanica, Bibbiano, Reggio Emilia, Italy
    Prof. Danilo Suvorov
15. Non Conductive Magnetic Materials for Microwave Absorbers
    Dr. Enzo Ferrara, Instituto Elettrotecnico Nazionale Galileo Ferraris Torino, Torino, Italy
    Dr. Darja Lisjak
16. Synthesis, characterization and application of nanostructure materials
    BI-SC/04-05-027
    Prof. Vera Dondur, Fakultet za fizičku hemiju, Univerza u Beogradu, Beograd, Serbia and Montenegro
    Prof. Mihael Drofenik

## R & D GRANTS AND CONTRACTS

1. Time- and position-controlled release of drug substances coated onto superparamagnetic nanoparticles
   Asst. Prof. Darko Makovec
2. Development of lightweight, super-hard composites based on AlMgB14-TiB2
   Dr. Kristoffer Krnel
3. Development of multifunctional B4C-Al and B4C-Mg composites for new products
   Dr. Srečo Skapin
4. Magnetic materials and intermetallic alloys
   Prof. Mihael Drofenik
5. Synthesis of 1D inorganic nanostructures, bionanostructures and preparation of composites
   Dr. Boštjan Jančar
6. Characterization on the nanometric scale
   Dr. Boštjan Jančar
7. Syntheses of nanoparticles and nanocomposites
   Asst. Prof. Darko Makovec

## RESEARCH PROGRAM

1. Advanced inorganic magnetic and semiconducting materials
   Prof. Mihael Drofenik
2. Contemporary inorganic materials and nanotechnologies
   Prof. Danilo Suvorov

# NEW CONTRACTS

1. Research of ferrite materials and magnetic fluids
   Iskra Feriti, d. o. o.
   Prof. Drofenik Mihael, Dr. Darja Lisjak
2. Preparation of multilayer ceramic structures
   KEKO OPREMA, d.o.o.
   Asst. Prof. Makovec Darko
3. Co-funding EUREKA project No. E!2913
   Ministry of Higher education, science and technology of the Republic of Slovenia
   Dr. Maček-Kržmanc Marjeta
4. Co- funding EUREKA project No. E!3451
   Ministry of Higher education, science and technology of the Republic of Slovenia
   Dr. Lisjak Darja
5. Co-funding NATO SfP project PST.NUKR.SFP 980881
   Ministry of Higher education, science and technology of the Republic of Slovenia
   Dr. Jančar Boštjan
6. Research of bio-soluble mineral fibres
   Termo, d.d.
   Prof. Suvorov Danilo
7. Investigation of materials and processes in MLC manufacturing
   EPCOS OHG
   Prof. Suvorov Danilo, Dr. Škapin Srečo
8. LTCC materials for multilayer LC filters
   EPCOS OHG
   Prof. Suvorov Danilo, Dr. Jančar Boštjan
9. Characacterisation of the materials for bio soluble mineral fibres production
   Paroc Group Oy
   Prof. Suvorov Danilo, Dr. Udovič Marko
10. Characterisation of bio soluble mineral fibres
    Heraklith AG
    Prof. Suvorov Danilo, Dr. Udovič Marko
11. Characterisation of the materials for mineral fibre production
    Gamma Meccanica S.p.A.
    Prof. Suvorov Danilo

# VISITORS FROM ABROAD

1. Dr. Ivan Sondi, Institut Rudjer Bošković, Zagreb, Croatia, 12. 5. 2006
2. Dr. Klaus Raichmann, EPCOS OHG, Deutschlandsberg, Austria, 19. 5. 2005
3. Dr. Nadine Millot, Universite de Bourgogne, Dijon, France, 18. 6. 2005
4. Dr. Jean-Luc Rehspringer, Institut de Physique et Chimie des Materiaux, Strasbourg, France, 24. 6. 2005
5. Dr. Claude Estournes, Institut de Physique et Chimie des Materiaux, Strasbourg, France, 24. 6. 2005
6. Prof. Gary Messing, Penn State University, USA, 24. 6. 2005
7. Prof. Sunggi Baik, Pohang University of Science and Technology, Pohang, Korea, 23.–24. 6. 2005
8. Prof. Suk- Joong L. Kang, Korea Advance Institute of Science and Technology, Daejeon, Korea, 23.–24. 6. 2005
9. Prof. I Wei Chen, University of Pennsylvania, Philadelphia, USA, 23.–24. 6. 2005
10. Prof. Mrityunjay Singh, NASA Glenn Research Center, Cleveland, USA, 23.–24. 6. 2005
11. Dr. Klaus Raichmann, Dr. Christian Hoffmann, EPCOS OHG, Deutschlandsberg, Austria, 23. 8. 2005
12. Dr. Anna Sztaniszlav, TKI Ferrit, Budapest, Hungary, 24.–26. 10. 2005
13. Dr. Tamas Banky, TKI Ferrit, Budapest, Hungary, 24.–26. 10. 2005
14. Dr. Laslo Uveges, Budapest University of Technology, Budapest, Hungary, 24.–26. 10. 2005
15. Dr. Mikolaj Baszun, Warsaw University of Technology, Warsaw, Poland, 14. 11. 2005
16. Stefan Thumser, dipl. ing., NETZCH, Selb, Germany, 24. 11. 2005
17. Dr. Klaus Raichmann, EPCOS OHG, Deutschlandsberg, Austria, 21. 11. 2005
18. Dr. Christian Hoffmann, EPCOS OHG, Deutschlandsberg, Austria, 21. 11. 2005
19. Prof. Ubavka Mioć, Faculty of Physical Chemistry, Beograd, Serbia and Montenegro, 6.–8. 12. 2005
20. Prof. Milorad Davidović, Vinča Institute of Nuklear Sciences, Vinča, Serbia and Montenegro, 6.–8. 12. 2005
21. Dr. Jovan Nedeljković, Vinča Institute of Nuklear Sciences, Vinča, Serbia and Montenegro, 6.–8. 12. 2005
22. Dr. Zoran Lausević, Vinča Institute of Nuklear Sciences, Vinča, Serbia and Montenegro, 6.–8. 12. 2005
23. Dr. Ivan Sondi, Institut Ruđer Bošković, Zagreb, Croatia, 6. 12. 2005

Visiting Researchers:
1. Vuk Uskoković M. Sc., Institute of Technical Sciences, Serbian Academy of Science and Art, Beograd, Serbia and Montenegro, 31. 5. 2004–31. 10. 2006
2. Dr. Hu Xing, Zhejiang University, Hangzhou, China, 16. 12. 2004–31. 12. 2006
3. Dr. Marco Peiteado Lopez, Instituto de Ceramica y Vidrio, Madrid, Spain, 1. 10. 2005–31. 9. 2006

# STAFF

**Researchers**
1. Prof. Mihael Drofenik*
2. *Dr. Miloš Komac***, retired 01. 12. 2005*
3. Dr. Darja Lisjak
4. Asst. Prof. Darko Makovec**
5. **Prof. Danilo Suvorov**, Head**
6. Dr. Srečo Davor Škapin
7. *Asst. Prof. Matjaž Valant, left 07. 11. 2005*
8. Dr. Igor Zajc
9. Asst. Prof.. Andrej Žnidaršič***

**Postdoctoral associates**
10. Dr. Boštjan Jančar
11. Dr. Uroš Kunaver***
12. Dr. Marjeta Maček Kržmanc
13. Dr. Marko Udovič

**Postgraduates**
14. Jana Bezjak, B. Sc.***
15. Boštjan Vladmir Bregar, B. Sc.***
16. Stanislav Čampelj, B. Sc.
17. Urban Došler, B. Sc.
18. Sašo Gyergyek, B. Sc.
19. Jakob Koenig, B. Sc.
20. Aljoša Košak, B. Sc.
21. Špela Kunej, B. Sc.
22. Manca Logar, B. Sc.
23. Urša Pirnat, B. Sc.
24. Irena Pribošič, B. Sc.
25. Matjaž Spreitzer, B. Sc.
26. Asja Veber, B. Sc.

**Technical and administrative staff**
27. *Aleksander Figelj, left 01. 10. 2005*
28. Maja Šimaga Saje, B. Sc.
29. Silvo Zupančič

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

# DEPARTMENT OF BIOCHEMISTRY AND MOLECULAR BIOLOGY B

***The research activities of the members of the Department of Biochemistry and Molecular Biology are focused on investigations of the properties and structures of proteins, their mechanisms of action and regulation, and of genes, from the structural and evolutionary viewpoint, as well as their physiological role in normal and pathological conditions.***

Head:
***Asst. Prof. Boris Turk***

**Proteolysis** (Head: Prof. Vito Turk)

Studies on protein degradation are a continuing research program, mainly covering the role of cysteine peptidases and their endogenous protein inhibitors in normal and pathological processes. The mechanism of the regulation of cysteine cathepsins' activity by autocatalytic activation of their zymogens was studied on cathepsins S and H. Although carboxypeptidases cathepsins X and B share common structural features and activity properties, these two related enzymes exhibit different profiles with respect to their protein distribution in cells and tissues and to their possible roles in malignancy. Lysosomal cathepsins, in addition to known caspases, play an important role in programmed cell-death or apoptosis. Our studies have contributed to the newly discovered role of lysosomal cathepsins in apoptotic pathways. Sensitization of stefin B-deficient thymocytes towards staurosporin-induced apoptosis showed that this process is not dependent on cysteine cathepsins. The inhibitors cystatin F and C are not co-localized, thus explaining their different roles in the cells. Studies of the effect of different inhibitors such as cystatins, thyropins, serpin endopin 2C and newly synthesized peptide inhibitors on the activity of various cysteine cathepsins were performed. Human stefin B represents a good model for understanding the mechanism of fibril formation, which plays an important role in aging, neurodegeneration, and other pathological events. International collaborations and the number of citations of their publications indicate the quality of the members of the group.

**Different localization and the level of expression of different endogenous protein inhibitors are crucial for the regulation of proteolysis.**

**Structural biology** (Head: Assist. Prof. Dušan Turk)

The conversion of globular proteins into amyloid fibres is a central feature of many neurodegenerative diseases, but the conformational transformations involved remain unclear. So far, domain swapping is the only mechanism describing a candidate transition at an atomic level. We have determined the crystal structure of a tetrameric form of the stefin B variant P79S at 1.4A resolution (Figure 1.). The structure revealed how two domain-swapped dimers of stefin B become entwined into tetramers by a previously unidentified process of extensive intermolecular contacts, termed loop swapping, which occurs concurrently with trans to cis proline 74 isomerization. The poster (S. Jenko, G. Gunčar, E. Žerovnik and D. Turk, Proline isomerization in stefin B: a crucial step towards amyloid fibril formation) presented at XX. Congress of the International Union of Crystallography (Florence IUCr 2005) received the PDB award, given for the best achievement of a young scientist in structural biology.

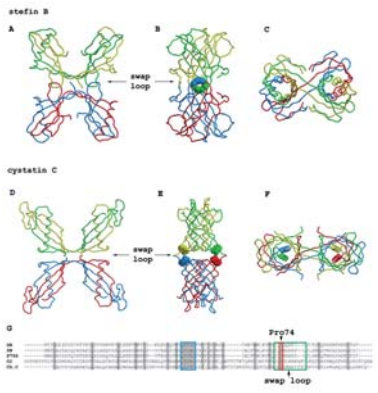


Figure 1: Gymnastics of stefin B: tetramer assembly.

**Structural biology: understanding of molecular mechanisms on the atomic level.**

**Toxins and Biomembranes** (Head: Prof. Igor Križaj )

In 2005, an important contribution to understanding the molecular mechanism of the action of ammodytoxins (Atx), neurotoxic secreted phospholipases $A_2$ ($sPLA_2$) from *Vipera a. ammodytes* venom, was that these toxins are highly active enzymes in the degradation of plasma membranes of different cell types, particularly that of the target cells, motoneurons. We observed that Atx interact in the neuron with protein disulphide isomerase (PDI), an oxido-reductase of the lumen of endoplasmic reticulum, which may be essential for internalization of the toxin into the cell. The molecular mechanism of presynaptic neurotoxicity of Atx was studied on a model of mouse motoneuron,

**Toxinology: a search for new molecular tools.**

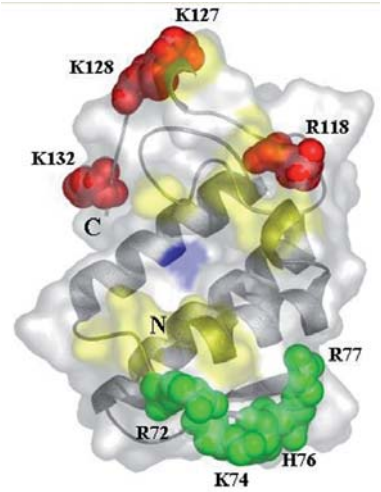


*Figure 2: Structural elements of Atx responsible for anticoagulant activity.*

*i.e.,* the NSC34 cell line, and on mouse neuromuscular preparations. Investigation of the influence of Atx on the cell cycle of the yeast *Saccharomyces cerevisiae* was concluded and published. In this publication, we further confirmed the relevance of yeast for the study of $sPLA_2$ action. We also investigated the anticoagulant activity of Atx, which is due to its interaction with the blood coagulation factor X (FXa) (Figure 2.), the constituents of *Vipera a. ammodytes* venom that affect hemostasis, the influence of Atx on isolated rat mitochondria, and Atx binding proteins of the viper serum. The research on chromoviruses of different groups of eukaryotes has been continued. We successfully performed, for the first time, a phylogenomic analysis of these transposable elements and published a review article on chromoviruses. The origin, diversity and evolution of L1 retrotransposons, from echinoderms to mammals, have also been studied. In vertebrates, three new and highly diverse L1 groups were recognized. In collaboration with other groups, we explained the origin, evolution, and functional diversity of a large tyroglobulin domain superfamily and continued the research on new methods of analysing DNA micro-array data. We also collaborated on the localization of Pex11 in yeast, the crystallization of the Atx-FXa complex, the role of $sPLA_2$ in mitochondria, the immunology of *Vipera a. ammodytes* venom, and serotherapy. Last year, our group assisted in organizing the 1st Meeting of Slovenian Bioinformaticists BIOINFO-2005. We obtained three new bilateral projects (SI-F, SI-I and SI-HR) and were invitedfor candidacy in applying for two international projects within the FP6 (EUROPHEN and CONCO).

**Pharmaceutical Biotechnology: Man and Environment** (Heads: Prof. Borut Štrukelj, Prof. Janko Kos)

**Pharmaceutical biotechnology to improve human health and environment.**

Two inhibitors of cysteine and serine proteases, clitocypin and CNSPI, respectively, have been isolated from mushroom *Clitocype nebularis*. For clitocypin we showed that it effectively inhibits human cathepsin K and legumain, but not caspases 3, 6, and 7. Clitocypin and lectins, also isolated from *Clitocype nebularis,* exhibited insecticidal activity on the model of the Colorado potato beetle. However, clitocypin and CNSPI provided only moderate inhibition of cysteine and serine proteolytic activity of intestains from the gut of the Colorado potato beetle. In this case, synthetic inhibitors, derivatives of xanthene, were more effective. Using the technology of protein arrays we identified seven yeast proteins interacting with clitocypin, which are associated with RNA processing in the nucleus, but none is cysteine protease. The impact of drought and rehydration on proteolytic activity was studied on *Ramonda serbica*, a rare plant capable of revitalisation when completely dried, and compared to *Phaseolus vulgaris*. We confirmed the role of serine proteases and aminopeptidases in plant response to drought. In *E. coli* and *Lactococcus lactis* we prepared the sweet protein brazzein. We demonstrated its sweet taste and prepared a probiotic expression system for its production in lacteal products.

## Some outstanding publications in the past three years

1. V. Turk, J. Kos and B. Turk, Cysteine cathepsins (proteases)-on the main stage of cancer, Cancer Cell 5 (2004), 409-410
2. S. Rabzelj, V. Turk and E. Žerovnik, In vitro study of stability and amyloid-fibril formation of two mutants of human stefin B (cystatin B) occurring in patients with EPM 1, Protein Sci. 14 (2005), 2713-2722
3. B. Turk, D. Turk and G. S. Salvesen, Regulation cysteine protease activity : essential role of protease inhibitors as guardians and regulators, Med. Chem. Rev. 2 (2005), 283-197
4. T. Petan, I. Križaj, M. H. Gelb and J. Pungerčar, Ammodytoxins, potent presynaptic neurotoxins, are also highly efficient phospholipase $A_2$ enzymes, Biochemistry 44 (2005), 12535-12545
5. U. Petrovič, J. Šribar, M. Matis, G. Anderluh, J. Peter KatalinićI, I. Križaj and F. Gubenšek, Ammodytoxin, a secretory phospholipase $A_2$, inhibits $G_2$ cell-cycle, Biochem. J. 391 (2005), 383-388
6. M. A. Jongsma, B. Štrukelj, B. Lenarčič, K. Gruden, V. Turk, H. J. Bosch and W. J. Stiekema, Method for plant protection against insects or nematodes by transformations with a nucleic acid encoding equistatin: Patent number: WO98/58068: United States Patent 6,681,578. [S.l.: s.n.], March 1, 2005. 80 pages

## Patent granted

1. Maarten Anthonie Jongsma, Borut Štrukelj, Brigita Lenarčič, Kristina Gruden, Vito Turk, Hendrik J. Bosch, Willem J. Johannes Stiekema
   Method for plant protection against insects or nematodes by transformations with a nucleic acid encoding equistatin
   Patent no. WO98/58068, US 6,681,578

## Awards and appointments

1. Saša Jenko Kokalj, Krka Award for Ph, D. thesis
2. Mojca Mattiazzi, Student Prešeren Award
3. Aleš Premzl, PRO NATURA international Award
4. Dušan Turk, Zois Award for excellent scientific achievements in structural biology

## Organization of conferences, congresses and meetings

1. IXth International Symposium on Proteinase Inhibitors and Biological Control, Brdo, June 25-29, 2005
2. 6th Meeting of The Slovenian Biochemical Society with international participation. Lipica [Slovenia], September 21-25, 2005 (co-organizers)
3. 22nd Winter School on Proteinases and their Inhibitors, Recent Developments, Tiers/Italy, March 2nd-6th, 2005 (co-organizers)
4. Sinapsa Neuroscience Symposium, 18th-20th November 2005, Ljubljana, Sinapsa, Slovenian Neuroscience Association (co-organizers)

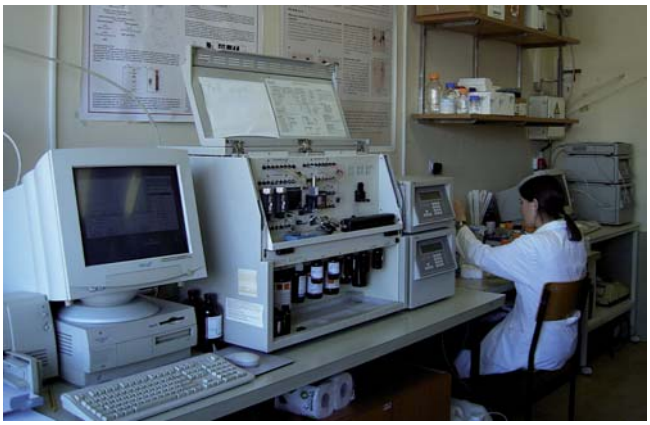

*Figure 3: Structural identification of proteins is important part of proteomics. The Edman degradation-based protein sequencer.*

# BIBLIOGRAPHY

## ORIGINAL ARTICLES


1. Gregor Anderluh, Ion Gutierrez-Aguirre, Sabina Rabzelj, Slavko Čeru, Nataša Kopitar-Jerala, Peter Maček, Vito Turk, Eva Žerovnik: Interaction of human stefin B in the prefibrillar oligomeric form with membranes: correlation with cellular toxicity. Eur. j. biochem., Vol. 272, pp. 3042-3051, 2005.
2. Galia Blum, Stefanie R. Mullins, Kinneret Keren, Marko Fonović, Christopher Jedeszko, Mark J. Rice, Bonnie F. Sloane, Matthew Bogyo: Dynamic imaging of protease activity with fluorescently quenched activity-based probes. Nature chemical biology, Vol. 1, pp. 203-209, 2005.
3. Tomaž Bratkovič, Mojca Lunder, Tatjana Popovič, Samo Kreft, Boris Turk, Borut Štrukelj, Uroš Urleb: Affinity selection to papain yields potent peptide inhibitors of cathepsins L,B, H, and K. Biochem. biophys. res. commun., Vol. 332, no. 3, pp. 897-903, 2005.
4. Tomaž Curk, Janez Demšar, Xu Qikai, Gregor Leban, Uroš Petrovič, Ivan Bratko, Gad Shaulsky, Blaž Zupan: Microarray data mining with visual programming. Bioinformatics (Oxf., Print), Vol. 21, no. 3, pp. 396-398, 2005.
5. Slavko Čeru, Sabina Rabzelj, Nataša Kopitar-Jerala, Vito Turk, Eva Žerovnik: Protein aggregation as a possible cause for pathology in a subset of familial Unverricht-Lundborg disease. Med. hypotheses, Vol. 64, pp. 955-959, 2005.
6. Laura Fontana, Yan Chen, Petra Prijatelj, Takao Sakai, Reinhard Fassler, Lynn Y. Sakai, Daniel B. Rifkin: Fibronectin is required for integrin aplhavbeta6-mediated activation of latent TGF-beta complexes containing LTBP-1. FASEB j., Vol. 19, pp. 1798-1808, 2005.
7. Katja Galeša, Jože Brzin, Jerica Sabotič, Dušan Turk: Crystallization and preliminary X-ray crystallographic analysis of the cysteine protease inhibitor clitocypin. Acta crystallographica. Section F, Structural biology and crystallization communications, Vol. 62, pp. 10-12, 2006.
8. Helena Gradišar, Jožica Friedrich, Igor Križaj, Roman Jerala: Similarities and specificities of fungal keratinolytic proteases: keratinases of Paecilomyces marquandii and Doratomyces microsporus in comparison to some known proteases. Appl. environ. microbiol., Vol. 71, no.7, pp. 3420-3426, 2005.
9. Uroš Gregorc, Andreja Doberšek, Guy S. Salvesen, Vito Turk, Boris Turk, Nataša Kopitar-Jerala: A novel caspase-7 specific monoclonal antibody. Immunol. lett., Vol. 98, pp. 167-169, 2005.
10. Uroš Gregorc, Saška Ivanova, Miranda Thomas, Vito Turk, Lawrence Banks, Boris Turk: hDLG/SAP97, a member of the MAGUK protein family, is a novel caspase target during cell-cell detachment in apoptosis. Biol. chem. (Print), Vol. 386, pp. 705-710, 2005.
11. Mirjana Grujić, Tina Zavašnik-Bergant, Gunnar Pejler, Metka Renko: Actinonin induces apoptosis in U937 leukemia cells. Cancer lett., Vol. 223, pp. 211-218, 2005.
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### Regular Papers

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2. Dušan Kordiš: Evolucijska genomika retroelementov pri kopenskih vretenčarjih (Tetrapoda). Zbornik, Prvo srečanje slovenskih bioinformatikov, Ljubljana, 2. december 2005, Gregor Anderluh, ed., 1. izd., Ljubljana, Fakulteta za računalništvo in informatiko, 2005, pp. 52-53.
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7. Eva Žerovnik, Sabina Rabzelj, Manca Kenig, Vito Turk: Correlation between stability and propensity to form amyloid-like fibrils. Amyloid and amyloidosis: [extended abstracts presentations from the Xth International Symposium on Amyloidosis, Tours, France, April 18-22, 2004], Martha Skinner, ed., Gilles Grateau, ed., Robert A. Kyle, ed., Boca Raton [etc.], CRC, cop. 2005, pp. 21-23.

## THESES

### Ph. D. Theses

1. Uroš Gregorc: The importance of selected members of the MAGUK family problems by caspases during apoptosis (Boris Turk)
2. Nina Slapar: The molecular aspect of the Colorado potato beetle (Leptinotarsa decemlineata Say) adaptation to plant defence response (Kristina Gruden, Borut Štrukelj co-mentor)
3. Jernej Šribar: Intracellular ammodytoxin-binding proteins and their possible role in the process of neurotoxicity (Igor Križaj)

### B. Sc. Theses

1. Janez Cvetek: The influence of ammodytoxin A on actin cytoskeleton in yeast *Saccharomyces cerevisiae* (Igor Križaj)
2. Tamara German: The role of cysteine proteases in differentation and adhesion of pro-monocyte U037 cells (Janko Kos)
3. Vesna Hodnik: Isolation of 2A2 monoclonal antibody and its association with cathepsin B (Janko Kos)
4. Nadja Jelnikar: The developement of the method for determination of sialic acid content in glycoproteins using fluorescent reagent 1,2-diamino-4,5-methylenedioxybenzene (Igor Križaj)
5. Špela Klofutar: Isolation, denaturation and oligomerisation of chimeric stefin A37B labeled with 15N in 13C (Metka Renko)
6. Jernej Kramarič: Cloning and expression of 5. and 6. tyroglobulin type 1 domain of tyroglobulin (Brigita Lenarčič)
7. Stanislav Mandelc: Introduction of procathepsin W coding region into the yeast *Pichia pastoris* and induction of its expression (Marko Dolinar)
8. Mojca Mattiazzi: In vitro interaction of secretory phospholipase A2 with recombinant yeast 14-3-3 proteins (Igor Križaj)
9. Klara Repovž: The relevance of the binding of ammodytoxin to calmodulin, in vivo, in yeast Saccharomyces cerevisiae (Igor Križaj)
10. Tatjana Stanonik: Preparation and expression of human pro-cathepsin O mutant (Vito Turk)
11. Franci Vreš: Analysis of recombinant human procathepsin W expression in the yeast *Pichis pastoris* (Marko Dolinar)
12. Tajana Zajc: Expression of human recombinant fusion protein (LDP+GFP) in mammalian cells HEK 293 (Boris Turk)
13. Andrej Zupan: The effect of a modification in the [Beta]-structure of non-toxic phospholipase $A_2$ on its enzymatic activity (Jože Pungerčar)

## PATENT APPLICATION

1. WO 20050260207 A1:. Monoclonal antibody neutralising cathepsin b activity and uses thereof; United States Patent Application (Janko Kos, Aleš Premzl, Nataša Kopitar Jerala, Xiao-hui Fan, Vito Turk, Marco Bestagno, Oscar Burrone)

# INTERNATIONAL PROJECTS

1. High Throughput Development of Drugs for Immunotherapy of (Auto) immune Diseases
   Drugs for Therapy
   6. FP; MRTW-CT-2004-512385
   EC; Prof. Frits Koning, Leiden University Medical Center, Leiden, RC Netherlands
   Asst. Prof. Dušan Turk
2. Safe Production and Use of Nanomaterials
   NANOSAFE2
   6. FP; NMP2-CT-2005-515843
   EC; Commissariat a l'Energie Atomique, Grenoble, France
   Asst. Prof. Boris Turk, Asst. Prof. Maja Remškar, Marko Žumer, Andrej Detela
3. Role of PDZ Domain Proteins from Maguk Family in Cell-Cell Detachment during Apoptosis
   CRP/SLO02-01, Contract No. 02/015
   International Centre for Genetic Engineering and Biotechnology (ICGEB), Area Science Park Padriciano, Trieste, Italy
   Asst. Prof. Boris Turk
4. Neurotoxic Phospholipases A2 - How They Produce the Neuromuscular Blockade and How to Prevent it
   NATO CLG 980899
   Dr. G. Rowan, University of Stratchclyde, Stratchclyde Institute of Biomedical Sciences, Department of Physiology & Pharmacology, Glasgow, Great Britain
   Prof. Igor Križaj
5. Proteolytic Activities in Trypanosoma Cruzi: Cruzipain, Metacaspase, Serine Carboxypeptidase
   BI-AR/03-05-001
   Prof. Juan Jose Cazzulo, Instituto de Investigaciones Biotechnologicals, Universidad Nacional de General San Martín, San Martin, Provincia de Buenos Aires, Argentina
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6. Structure and Dynamics of Biological Macromolecules
   BI-HR/05-06-028
   Dr. Marija Luić, Institut "Ruđer Bošković", Fizička kemija, Laboratorij za kemijsku i biološku kristalizaciju, Zagreb, Croatia
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7. Identification of Protease Interaction Networks by Proteomics
   BI-ES/04-05-013
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8. Identification of Interactions of PEX11, the Yeast Nuclear Receptors Homologue BI-US/05-06-007
Dr. Joseph L. DeRisi, University of California San Francisco, San Francisco, USA
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# R & D GRANTS AND CONTRACTS

1. Role of cysteine proteases in inflammation
Asst. Prof. Boris Turk
2. Phospholipases in yeast Saccharomyces cerevisiae
Prof. Igor Križaj
3. Molecular basis of tolerance to abiotic stress in Phaseolus sp.
Dr. Marjetka Kidrič
4. Role of cysteine cathepsins as immunomodulators in rheumatoid arthritis
Asst. Prof. Boris Turk
5. Synthesis of 1D inorganic nanostructures , bionanostructures and preparation of composites
Asst. Prof. Boris Turk
6. Nanometer scale Characterization
Asst. Prof. Dušan Turk
7. Biological Methods of Wastewater Treatment
Asst. Prof. Dušan Turk
8. Development of new drugs and biochips
Asst. Prof. Boris Turk
9. Development of readiness plan and measures against bioterorism
Asst. Prof. Boris Turk

# RESEARCH PROGRAMS

1. Structural Biology
Asst. Prof. Dušan Turk
2. Proteolysis and its regulation
Prof. Vito Turk
3. Toxins and Biomembranes
Prof. Igor Križaj
4. Pharmaceutical biotechnology - Man and Environment
Prof. Borut Štrukelj, Prof. Janko Kos

# NEW CONTRACTS

1. ELISA assay development and measurements of serum concentrations of substance X
Lek, d. d.
Asst. Prof. Boris Turk
2. Determination of the crystal structure of beta lactamase inhibitors
Lek, d. d.
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# DEPARTMENT OF ENVIRONMENTAL SCIENCES O-2

***The focus of the multidisciplinary research activities of the Department of Environmental Sciences is to investigate the interplay between the reciprocal physical, chemical and biological processes that are shaping our environment, and human activities. In 2005, two research groups joined the department, the Radon Centre and the Tritium and Strontium Group, thus extending the research to the studies of radon and the national radioactivity monitoring network. An important part of the basic and applied research of the department is carried out by the Centre for Mass Spectrometry, the mobile unit of the Ecological Laboratory and the Centre of Excellence "Eco-technologies", supported by EU structural funds, which now acts as a link between scientific research and industry.***

Head:
***Dr. Milena Horvat***

In the field of environmental analytical chemistry some new analytical procedures were developed and applied on different sample matrices to study speciation of elements (Al, As, Cr, Hg, Ni, Sb, Sn, Zn) and processes governing their distribution. A new analytical procedure has been developed for reliable determination of Al species in tea infusions based on a combination of size-exclusion chromatography (SEC) and anion-exchange fast protein liquid chromatography (FPLC) with inductively coupled plasma optical emission spectrometry (ICP-OES) detection. Identification of Al binding ligands was performed by the use of the electro-spray tandem mass spectrometry (ES-MS-MS) technique. The combination of cation and anion-exchange FPLC with ICP-OES detection and identification of Al binding ligands by ES-MS-MS was also used in the investigations of the distribution of Al species in the roots of Al-tolerant Chinese cabbage. It was demonstrated that the prevailing Al species in plant roots was Al-citrate. The capability of different analytical procedures was investigated for the determination of Cr(VI) in cements, following new legislative demands. In cooperation with oncologists, platinum (Pt) was determined in tumour cells after electro-chemotherapy by ETAAS technique.

A new field of arsenic speciation in coal samples was started and, for the first time, organic arsenic species tetramethyl arsonium ion and monomethyl arsonic acid were discovered in samples of coal from the Velenje coal basin. In collaboration with the University Medical Centre Ljubljana, we also studied the consequences of the use of arsenic trioxide in the treatment of acute promyelocytic leukaemia and plasmacytoma (multiple myeloma) by examining arsenic methylation and excretion in the urine of patients and the influence of the treatment on urine metallothionein content. Beside that we also followed the effect of arsenic on selenium metabolism at the same patients. Experimentally we followed arsenic trioxide uptake, and biotransformation and interactions with metallothioneins in cell cultures to get insight into the metabolism of arsenic in the nervous system and in multiple myeloma cells (astrocytoma cell line and multiple myeloma bone marrow cells). In addition, different extraction procedures were applied to improve the extraction efficiency of arsenic compounds from lichens and to study the metabolism and transformation of arsenic in lichens.

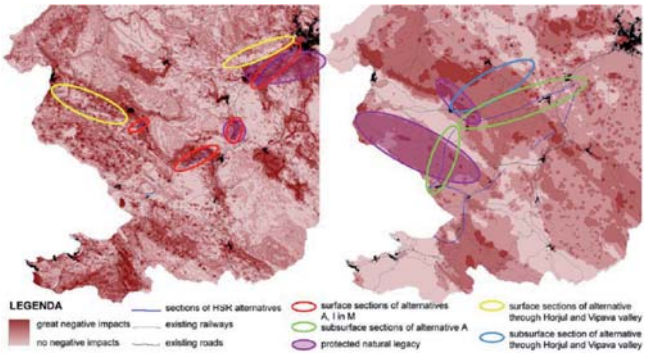


*Figure 1: Surface vulnerability map (left) and subsurface vulnerability map (right) with marked sections of HSR alternatives A, I and M and marked 'new' alternative through Horjul valley and Vipava valley.*

A procedure for the determination of selenium (Se) species by HPLC-UV-HG-AFS in plants exposed to higher concentrations of Se was developed and optimised, since plants are a potential nutritional source of selenium in human and animal nutrition, and Se bioavailability is conditional on the form in which it is present. Se species were isolated from samples using enzyme hydrolysis with Protease XIV, separation of soluble selenium species was carried out on ion exchange columns, and for detection, a UV-HG-AFS system was used. In cooperation with the Department of Agronomy of the Biotechnical Faculty in Ljubljana, pumpkins, beans, peas and buckwheat were cultivated with foliar Se treatment, as were the beans, whose seeds were soaked in nutrient solution containing Se. In all cases SeMet was found to be the main species, except in buckwheat leaves and flowers, where it was Se (VI), and in bean seeds, SeMetSeCys.

In the area of nuclear-related techniques, applicability of the Fast Pneumatic Transfer System (FPTS) with a sample transfer time of 1 s was tested and evaluated for the determination of Mn, V, and short-lived F and Se in biological materials. In the field of radiochemical neutron activation analysis (RNAA), new techniques for trace-

element determination in biological materials were developed: sequential procedures for the determination of Mn, and Co, and for the determination of I and Mn. The $k_0$-standardized method of instrumental neutron activation analysis ($k_0$-INAA) has been used for the characterisation of macro and trace elements in different sample matrices. The method is validated via different certified reference materials. In addition, $k_0$-INAA has been optimised and used for different appreciative work, and also for inter-laboratory comparison studies of proposed new reference materials.

Radio-analytical procedures for the identification and characterisation of radioactive waste were developed and/or refined, with particular emphasis on procedures for the determination of actinides. New equipment for the 'Hot cells' facility was obtained and tested, thus strengthening the waste management capabilities available to customers. An electronic supportive tool for hazardous waste identification has been developed within the framework of an EU Leonardo da Vinci project.

In the area of organic analytical chemistry, a series of analytical procedures for the determination of representatives of 'new emerging contaminants' (e.g., pharmaceutical and personal care products) in water and sediment samples were developed. The procedures developed were applied to a wide series of samples from Slovenia whose toxicity and genotoxicity was also studied. In parallel, the elimination of selected compounds was studied on a pilot waste water treatment plant. We have also evaluated the pollution of Slovene waters (rivers, potable water sources, well water) with non-steroidal anti-inflammatory drug (NSAIDs) representatives. Also, the biodegradation of selected NSAIDs drugs have been tested in a reactor under controlled conditions and compared with the efficiency of various wastewater treatment plants with classical configurations and reverse osmosis.

*Figure 2: Fast Pneumatic Transfer System (FPTS) with sample transfer time from the reactor core to the HPGe detector of 1 s is used for analyses of short-lived isotopes using INAA method*

The Centre for Mass Spectrometry (CMS) supports the research of about 30 national and international research programs, projects, and some technological applications of the pharmaceutical industry in Slovenia. Basic research performed in CMS includes determinations of weakly-bound non-covalent complexes and electrospray ionisation studies of proteins.

In 2005 we participated with great success in the following inter-laboratory studies: BAM CCQM-P34.1 (Determination of Cr, Cu, Fe, Mn and Zn in Aluminium alloy), QUA-NAS Trace elements in "Urban dust", CCQM-44 & CCQM-P70 Trace elements in Sewage Sludge and in three different concentration levels of Synthetic multi-element standard (SMELS). Particular emphasis was put to the methodology development aimed at assessing the measurement uncertainty of the $k_0$-INAA method.

The focal point of Radon Centre is basic research, generating new knowledge and experience which are reflected in our applied research. In 2005 we tried to evaluate the influence of meteorological and climatic parameters on the unattached fraction of radon decay products in air at workplaces. Great attention was paid to the investigations of radon ($^{222}$Rn) transport and to identification of anomalies in radon levels, as well as geochemical and geophysical quantities resulting from seismic activity. Radon has been continuously recorded in thermal water at a fault zone in the NW part of Slovenia, as well as in soil gas at some other sites in Friuli and Sicily in Italy, and at Hokkaido in Japan. Machine learning protocols were successfully used to identify the anomalies caused by seismic activity. Outdoor radon surveys at 60 locations around the country, carried out in collaboration with the Department of Physics of Low end Medium Energy for the Ministry of Environment and Spatial Planning, Slovenian Nuclear Safety Administration, were one of the significant projects in 2005.

The EU funded project MERCYMS "An integrated approach to assess the mercury cycle in the Mediterranean basin" was concluded. Two extensive international cruises were organised in the Mediterranean in order to better understand cycling of this toxic element in the open and coastal waters, in particular speciation of mercury in the water column, sediment-water and water-air boundary conditions, and its uptake by zooplankton. Measurements significantly improved the current mass balance calculation of mercury and contributed to the development of improved integrated modelling tools. Further development of erosion models in areas impacted by the Idrija mercury mine was also in the focus of mercury research.

The effects of elevated environmental mercury on terrestrial isopods (Crustacea) and their gut microbiota was also investigated, focusing on the bio-available fraction of Hg in environmental samples using Hg sequential extraction techniques. In order to understand the combined effects of the mercury pollution and animal-bacterial interaction on organic matter degradation processes, stable isotopic compositions of carbon ($\delta^{13}$C) and nitrogen ($\delta^{15}$N) were measured using isotope ratio mass spectrometry. The cytotoxicity of Hg to the animals and changes in gut microbiota in two species of terrestrial isopods, collected in different seasons at different distances from the mercury mine and smelter in Idrija, Slovenia, were studied. Cytotoxicity was measured by two methods for lysosomal membrane stability (LMS) assessment - lysosomal latency (LL) and neutral red retention (NRR) assay performed in the isopods digestive glands.

In collaboration with the University Clinical Centre in Ljubljana, a number of health related studies on exposure to mercury in Idrija were carried out on women of childbearing age and pregnant women. An assessment of mercury exposure due to increased consumption of canned fish in Slovenia was also implemented

Mercury behaviour and release in the production of clinker in Salonit Anhovo was carried out as a part of industry-related projects. Among those, it is important to mention the environmental assessment of mercury in the abandoned chlor-alkali plant in Tuzla (Bosnia and Herzegovina), in Anhovo (W Slovenia) and in the production of natural gas at Molve, operated by the Ina Naftaplin Company, Zagreb, Croatia.

Research on the EU funded project "Sava River Basin: Sustainable Use, Management and Protection of Resources" (SARIB), coordinated by the Department of Environmental Sciences, was focused on the estimation of the extent of pollution and anthropogenic inputs of toxic metals to Sava River sediments and to the characterisation of persistent organic pollutants. A combination of major element and stable isotope tracers was used in order to understand the hydrological situation, weathering processes, and carbon and sulphur budgets in the Sava River basin.

An original method was developed for modelling PCB pollution dynamics for the specific karstified aquifers. Specific sampling and measurement methods for the determination of the PCB concentrations were applied, followed by applying models that can couple air and water mass fluxes within aquifers. In order to reproduce the PCB concentrations in the Krupa river water, modelling procedures, based on a non-linear feed-forward artificial neural network model, involving correlations between atmospheric precipitation, river flow rate and PCB concentrations, were used. With such a model the evaluation of mass balance of PCB in the hinterland, in the karstic underground, and in the Krupa River was possible.

The contamination of peloid muds from Central Adriatic (Croatia) by toxic elements (As, Cd, Cu, Hg, Pb, Se) was studied in order to assess their suitability for application in medical rehabilitation.

In the field of stable isotope geochemistry, investigation of decomposition and recycling of organic matter in aquatic environments was continued. Compound specific carbon isotope analyses of lipids were applied to confirm the results obtained by bulk sample measurements in studies of C recycling in alpine lakes. The carbon and nitrogen transfer in the microbial loop in the Northern Adriatic was analysed and geochemical maps of $\delta^{15}N$ values in particulate organic matter and organisms (*Aplysina aerophoba, Balanus perforatus, Anemonia sulcata*) were created for the area around the Vrgada fish farm (Central Adriatic, Croatia). These geochemical maps are used for tracing the dispersion of N loading generated by aquaculture and sewage, providing important information for the management of marine ecosystems impacted by municipal waste. Baseline concentrations of nitrate and its stable isotope composition were monitored in unpolluted soil at Ljubljansko Polje in order to determine the natural background of nitrate loads in the groundwater used by the Ljubljana municipal water supply. In collaboration with the Geological Survey of Slovenia we investigated the isotopic composition of domestic and foreign bottled waters available on the Slovene market. Determination of carbon isotopic composition enabled us to distinguish between natural and artificial sparkling waters and to determine their origin.

*Figure 3: Measurement of emanations of gaseous Hg and Rn related to volcanic activity at Mt. Etna (Italy): a complete mass balance is essential for understanding of global cycles of these elements*

Palaeo-ecological research on the Ljubljana Marsh was carried out in order to investigate whether palaeo-ecological changes in the basin (such as lake water and marsh groundwater fluctuations, geochemical processes, human impact, and vegetation changes) are synchronous and causally connected. Further, carbon and nitrogen stable isotopes were used in combination with other chemical analysis to determine the processes influencing the carbon cycling in the soil in different forest ecosystems, where stable oxygen isotopes were used to study water availability to the trees.

The monitoring of metal pollutant trends in mussels and marine sediments was continued in cooperation with the National Institute of Biology. The radioactivity survey of the Postojna Cave ($^{222}Rn$), the Žirovski vrh uranium mine ($^{226}Ra$, $^{238}U$, $^{230}Th$, $^{210}Po$, $^{210}Pb$), and the Krško Nuclear Power Plant ($^{3}H$, $^{14}C$, $^{89}Sr/^{90}Sr$) was continued. The national database on the isotopic parameters of Slovenian wines was also supplemented and the data obtained were sent to the European data bank established for all EU wine-producing countries. In addition, the isotopic parameters ($\delta^{18}O$, $\delta D$ and $^{3}H$) of the Sava river were included into the IAEA Global Network of Isotopes in Rivers (GNIR) database established in 2005.

The Strategic environmental assessment associated with high-speed trains through Slovenia (EU fifth corridor) has been accomplished. The new HSR infrastructure between Trieste and Ljubljana, which will enable travel speeds of 250 km/h for combined freight transport and at least 300 km/h for passenger transport, is problematic from an environmental point of view. None of the proposed alternative routes (A, I, M) has been assessed as suitable.

*Figure 4: Lysimeter station at an unpolluted meadow at Kleče near Ljubljana: collection of soil water for determination of background levels of pollutants threatening the drinking-water supply for the Ljubljana Municipality*

Therefore, it was recommended to the planners (Ministry of the Environment, Ministry of Transportation, Agency for railway transport) to check other possibilities for routing HSR in the fifth trans-European corridor through Slovenia. The main environmental reasons for this conclusion are associated with tunnelling through the Karst (multiple uncertainties are relevant in this respect, making environmental predictions limited; construction costs are uncertain; psychological effects associated with safety of long tunnels is also an issue), conflicts with Natura 2000, and with groundwater/drinking water resources protection. Modelling the results of space suitability for HSR routing in SW Slovenia show that a new railway through the Vipava valley could be a better option. The feasibility of the alternative route still needs to be checked and agreed with Italy, since routing through Vipava valley would require an adaptation of the route in Italy.

The work on the ARAMIS project (Accidental Risk Assessment Methodology for Industries) has also been concluded. The ARAMIS methodology was successfully tested in the Slovenian industry Nafta Petrochem.

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# THESES

## Ph. D. Theses

1. Polona Smrkolj, Determination of selenium species in cultivated plants exposed to increased selenium concentrations (V. Stibilj)
2. Marija Osvald: Controlled increase of selenium content in grain of selected bean cultivars (Phaseoulus vulgaris L.) for production of functional food) (V. Stibilj)
3. Svetozar Polič: PCB pollution dynamic and environmental impact in the Krupa river Karstic region (P. Stegnar)

## M. Sc. Thesis

1. Petra Pavšič Mikuž: Metals and microelements in mosses and epiphytic lichens in Slovenia (Z. Jeran)

## B. Sc. Theses

1. Jan Antonič: The determination of pharmaceutical residues in sediment samples
2. Nina Bednaršek: Choice of method for determining metabolites on Pseudomonas putida (E. Heath)
3. Petra Cuderman: Development of analytical procedures for determination of personal care product residues in water samples
4. Matevž Hočevar: Radon distribution in soil at the Labotski prelom near Homec (T. Dolenec, M. Vrabec, J. Vaupotič)
5. Anja Kušar: Risk perception of mercury pollution in Idrija (M. Horvat)
6. Simona Murko: Use of matrix modifiers for the determination of As, Cd and Pb in sediments by electrothermal atomic absorption spectrometry (J. Ščančar)
7. Miha Naglič: Accumulation of mercury in fish from the Idrijca River (M. Horvat)
8. Tina Osterman: Critical evaluation of analytical procedure of the determination of CR(VI) in decolorized leather samples by spectrophotometry (J. Ščančar)
9. Patricija Pernat: Effect of Arsenic Trioxide on Selenium Metabolism (I. Falnoga)
10. Martina Pucihar: Pollution of Iški vršaj aquifier: the possibility and probability (N. Ogrinc)
11. Marija Žagar: Methanogenesis in a high mountain alpine lake (Lake on Planina pri Jezeru) (N. Ogrinc)

# INTERNATIONAL PROJECTS

1. Network of Reference Laboratories for Monitoring of Emerging Environmental Pollutants
   NORMAN
   6. FP; 018486
   EC; Dr. Valeria Dulio, INERIS - Direction Scientifique, Verneuil-en-Halatte, France
   Dr. Ester Heath
2. Sharing Experience on Risk Management (Health, Safety, Environment) to prepare Future Industrial Systems
   SHAPE-RISK
   6. FP; NMP2-CT-2003-505555
   EC; Institut National de l'environnement industriel et des risques, Verneuil en Halatte, France
   Asst. Prof. Branko Kontič, Dr. Marko Gerbec
3. Worldwide Remediation of Mercury Hazards through Biotechnology
   BIOMERCURY
   6. FP; NMP2-CT-2004-505561
   EC; Gesellschaft für Biotechnologische Forschung MBH, Braunschweig, Germany
   Prof. Milena Horvat, Dr. Andrej Stergaršek
4. Sava River Basin: Sustainable Use, Management and Protection of Resources
   SARIB
   6. FP; INCO-CT-2004-509160; EC
   Dr. Radmila Milačič
5. An Integrated Approach to Assess the Mercury Cycling in the Mediterranean Basin
   MERCYMS
   5. FP; EVK3-CT-2002-00070
   EC; Allegrini, National Research Council of Italy (CNR.IIA), Rome, Italy
   Prof. N. Pirrone, Institute for Atmospheric Pollution (CNR.IIA), Rende, Italy
   Prof. Milena Horvat
6. Improving the Infrastructure for Metrology in Chemistry in the Candidate New Member State
   QUA-NAS
   5. FP; G7-RT-CT-2002-05110

EC; Prof. Carmen Camara, Dr. Riansares Munoz Olivas, Universidad Complutense de Madrid, Madrid, Spain
Prof. Milena Horvat, Dr. Polona Vreča

7. European Virtual Institute for Speciation Analysis for Improvement of Health, Food, Industry and Environmental
EVISA
5. FP; G7RT-CT-2002-05112
EC; Dr. Wolfgang Buscher, Westfälische Wilhelms-Universität Münster, Institut für Chemo-und Biosensorik, Münster, Germany
Dr. Radmila Milačič
8. Comparability of the Operation and Evaluation Protocols of European Proficiency Testing Schemes
COEPT
5. FP; GTC1-2002-73002
EC; Adriaan M. H. van der Veen, Nmi Van Swinden Laboratorium B. V., AR Delft, The Netherlands
Prof. Milena Horvat, Dr. Janez Ščančar
9. The European Virtual Institute for Reference Materials
VIRM
5. FP; G7RT-CT-2002-05104
EC; Dr. Kees J. M. Kramer, MERMAYDE, Monitoring of Water, Sediment & Biota, AC Bergen, Netherlands
Prof. Milena Horvat
10. Lead Free Solder Materials
COST 531; EC
Dr. Arkadij Popovič
11. Xenobiotics in the Urban Water Cycle
COST 636; EC
Dr. Ester Heath
12. Hazardous Waste Management Training Programme
HAZTRAIN
Leonardo da Vinci; IRL-04-B/P-PP-153225
EC; Clean Technology Centre, Cork Institute of Technology, Cork, Ireland
Dr. Borut Smodiš
13. Alpen Corridor South
AlpenCorS
INTERREG III B, Alpen Space
Programme for Alps, Programme for Central, Adriatic, Danube and Northeast Europe Regions (CADSES)
Regione Veneto, Italy
Asst. Prof. Branko Kontić
14. Potential Human Exposure to Pb, Cd, Zn, As and Hg Through Consumption of Foodstuffs Grown or Bread Near Mining Areas in Slovenia (Pb and Zn Mine Mežica and Idrija Mercury Mine)
11929/R0
IAEA, Vienna, Austria
Dr. Ingrid Falnoga
15. Facility for Cyclotrone Production of Short Lived Medical Isotopes
SLO/4/004
IAEA, Vienna, Austria
Prof. Peter Stegnar
16. Chemical and Stable Isotope Investigation of the Sava and Soča Rivers in Slovenia
12642/R1
IAEA, Vienna, Austria
Dr. Nives Ogrinc
17. Training of Ms Zorana Ilić
IAEA Fellow, BOH/05004
IAEA, Vienna, Austria
Asst. Prof. Janja Vaupotič
18. As2O3 in the Treatment of Acute Promyelocytic Leukemia
SI-AT/04-05/010
Dr. Walter Gössler, Institute of Chemistry, Analytical Chemistry, Karl-Franzens University Graz, Graz, Austria
Dr. Zdenka Šlejkovec
19. Neutron Activation Analysis (NAA) of Short-lived Radionuclides for Trace Element Determinations
BI-CZ/05-06/002
Prof. Jan Kučera, Academy of Sciences of the Czech Republic, Nuclear Physic Institute, Department of Nuclear Spectroscopy, Řež near Prague, Czech Republic
Dr. Borut Smodiš
20. Organotin Compounds in the Environment
PROTEUS
Dr. Gaetane Lespes, LCABIE-UMR CNRS 5034, Universite de Pau et des Pays de l'Adour, Faculte des Sciences, Pau, France
Dr. Janez Ščančar
21. Measurements of Radioactivity in Adriatic and Agean Sea by using Floating Buoys and Satelite Communication. Various Off -line Techniques will also be used for the Analysis of Environmental Samples.
BI-GR/02-05-012
Dr. Christos Tsabaris, National Centre of Marine Research, Institute of Ocenography, POSEIDON System, Anabyssos, Greece
Dr. Ljudmila Benedik
22. Biogeochemical Cycling of Carbon and Assessment of Shifts in Sediments in Lake Pamvotis (Greece) and Bohinj (Slovenija)
BI-GR
Dr. Constantine Stalikas, University of Ioannina, Department of Chemistry, Laboratory for Analytical Chemistry, Ioannina, Greece
Dr. Polona Vreča
23. Survey of Radon Concentrations in Public Buildings
BI-GR/02-05-013
Prof. Kostas Ioannides, The University of Ioannina, Ioannina, Greece
Asst. Prof. Janja Vaupotič
24. Isotopic Composition of Carbon Dioxide as an Indicator of Atmospheric Pollution
BI-HR/04-05-013
Dr. Ines Krajcar Bronić, Institut "Ruđer Bošković", Zagreb, Croatia
Dr. Polona Vreča
25. Formation of Organometal Compounds in Mass Spectrometry
BI-HR/05-06-002
Dr. Dunja Srzić, Institut "Ruđer Bošković", Zagreb, Croatia
Dr. Bogdan Kralj
26. Development of a Method for Field Measurement of Radon and Thoron Alpha Activity in Soil
BI-HR/05-06-020
Dr. Delko Barišić, Institut "Ruđer Bošković", Zagreb, Croatia
Asst. Prof. Janja Vaupotič
27. Relevance of Metal Speciation in Human and Experimental Toxiocology
Prof. Paolo Zatta, Centro CNR Metalloproteine, Dipartimento di Biologia, Universita di Padova, Padova , Italy
Dr. Radmila Milačič
28. Definition of Limits and Field Applicability of the Most Widely Used Sampling Methodologies for Soil and Water
Dr. Umberto Sansone, ANPA - Agenzia Nazionele per la Protezione dell' Ambiente, Rome, Italy
Asst. Prof. Zvonka Jeran
29. Analysis of Soil Samples by Multi-elemental Instrumental Neutron Activation Analysis
INAA - SOILSAMP Project
00-31-5035
Dr. Maria Belli, APAT - Agenzia per la Protezione dell' Ambiente e per i Servizi Tecnici, Rome, Italy
Asst. Prof. Zvonka Jeran
30. Characterization of Food Products in Apulia and Slovenia by Spectroscopic and Chemometric Methods: Similarities and Differences
Prof. Antonio Sacco, Universitf di Bari, Dipartimento di Chimica, Bari, Italy
Dr. Nives Ogrinc
31. Mercury Emission, its Influence and its Correlation to Radon in Mount Etna Area
Dr. Salvatore Giammanco, Instituto Nazionale di Geofisica e Vulcanologia, Sezione di Palermo, Palermo, Italy
Dr. Jože Kotnik
32. Monitoring of Physical and Chemical Parameters Connected with Crustal Deformations in a Seismic Area: The Italy and Slovenia Border Region
BI-IT/02-05-004
Dr. Anna Riggio, Instituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Trieste, Italy
Asst. Prof. Janja Vaupotič
33. Monitoring of Chemical and Physical Parameters at the Seismic Active Zone at the Slovenian-Italian Border at the Etna Volcanic Area
Dr. Anna Riggio, Instituto Nazionale di Oceanografia e di Geofisica Sperimentale, Sgonico Trieste, Italy
Asst. Prof. Janja Vaupotič
34. The Estimation of the Impact of Mercury Released in Environmental by a Human Activity The Behavior of Mercury Released from the Mining Area
JSPS - Grant no. 15404003
Prof. Takashi Tomiyasu, Kagoshima University, Faculty of Science, Department of Earth and Environmental Sciences, Japan
Prof. Milena Horvat
35. Assessment of the Contribution of Trees to the Global Radon Inventory
SLO-JPN
Prof. Hirotaka Ui, Toyama University, Faculty of Education, Laboratory Global Environment, Gofuku, Toyama City, Japan
Asst. Prof. Janja Vaupotič
36. Relation between Radon Level in Soil Gas and Subsoil Properties
SLO-JPN
Dr. Ryoko Fujiyoshi, Hokkaido University, Graduate School of Engineering, Hokkaido, Japan
Asst. Prof. Janja Vaupotič
37. Integration of Hg Removal (RHg) in the Process of Flue Gas Desulphurization (FGD) in Thermal Power Plants
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Yan Yin Jiang, Shanghai Research Institute of Environmental Industry, Shanghai Academy of Environmental Sciences, Shanghai, PR China
Prof. Milena Horvat
38. Application of Speciation Analysis in Environment Protection and Food Industry
BI-HU/04-05-015
Dr. Peter Fodor, Szent Istvan University, Faculty of Food Sciences, Dept. of Applied Chemistry, Budapest, Hungary
Dr. Zdenka Šlejkovec

39. Elemental Composition of Minerals from The Rebublic of Macedonia
BI-MK/05-06-018
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Dr. Radojko Jaćimović
40. NAA and PIXE Techniques for Microcharacterisation of Trace Elements and Their Species in Environmental Samples
BI-PT-04-06-010
Dr. Miguel Reis, Instituto Tecnologico e Nuclear (ITN), Sacavem, Portugal
Asst. Prof. Zvonka Jeran, Dr. Matjaž Kavčič
41. Optimisation of Procedures for Microprecipitation of Actinides in Samples in Decommission of Nuclear Reactor
AKTINIDI
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Dr. Krunoslav Subotić, Institut za nuklearne nauke Vinča, Belgrade, Serbia and Montenegro
Dr. Ljudmila Benedik
42. Studies of Depleted Uranium in South Serbia
DU; BI-SC/04-05-038
Dr. Jagoš Raičević, Institut za nuklearne nauke Vinča, Beograd, Serbia and Montenegro
Dr. Borut Smodiš
43. Radon Map of Montenegro
BI-SC/04-05-029
Dr. Nevenka Antović, Prirodno-matematički fakultet, Univerzitet Crne Gore, Podgorica, Serbia and Montenegro
Prof. Ivan Kobal
44. Assessment of Population Exposure to Radon and Thoron in Living and Working Environments in Slovenia and Serbia and Montenegro
NORM; BI-SC/04-05-002
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Asst. Prof. Janja Vaupotič
45. Safety Assessment and Remediation Strategies for Heavily Arsenic-contaminated Sites
PSP 21/2005
Prof. Hylke Jan Glass, University of Exeter, Camborne School of Mines, Cornwall, Great Britain
Dr. Zdenka Šlejkovec
46. Microbial Transformations and Biogeochemistry of Mercury in the Idrijca/Soča River system
BI-US/05-06-011
Dr. Mark Edward Hines, Department of Biological Sciences, University of Massachusetts Lowell, Lowell, MA, USA
Prof. Milena Horvat
47. Mineral Weathering and Carbon Transformations in Carbonate-Rich Landscapes
BI-US/05-06-003
Prof. Walter Lynnn M., University of Michigan, Geological Sciences, Ann Arbor, MI, USA
Dr. Nives Ogrinc
48. Establishment of an International Institute for Rural and Environmental Health in Bratislava Training and Research Grant
Prof. Thomas Cook, prof. dr. Ivan Ciznar, International Institute for Rural and Environmental Health, supported by Fogarty International Center and National Institute of Health, Bethesda, USA
Asst. Prof. Branko Kontić

# R & D GRANTS AND CONTRACTS

1. Sources and cycling of organic matter in coastal sea
Dr. Polona Vreča
2. Stress and response to the stress in terrestrial isopode Porcellio scaber and in water leek Lemna minor: mechanistic approach
Asst. Prof. Milena Horvat
3. Biogeochemical cycling of carbon and nitrogen in eutrophic lakes
Dr. Polona Vreča
4. Identification of anomalies in radon transport caused by seismic activity
Asst. Prof. Janja Vaupotič
5. Biogeochemical cycles and pollution with organotin compounds: development and validation of analytical procedures
Dr. Janez Ščančar
6. Pathways of carbon, nutrients and pollutants through food webs in Slovenian mountain lakes
Asst. Prof. Milena Horvat
7. The impact of microbial processes on Hg biomagnification in food webs of the Gulf of Trieste (N Adriatic Sea)
Asst Prof. Milena Horvat
8. Identification of structures, soils and deffects
Prof. Ivan Kobal
9. As2O3 biotransformation and clinical efficacy correlations in the treatment of APL
Dr. Zdenka Šlejkovec
10. The influence and interactions of chromium and iron species in yeast cells
Asst. Prof. Radmila Milačič
11. Impact of selenium on the yield of vegetables and crop plants
Asst. Prof. Vekoslava Stibilj
12. The response of soil organic matter and natural ecosystems (primarily forests) to climate change
Dr. Polona Vreča
13. Ljubljansko barje - archaeological landscape in flux
Asst. Prof. Nives Ogrinc
14. Carbon transport processes and mechanisms in forest ecosystems
Asst. Prof. Nives Ogrinc
15. Bioremediation of mercury in contaminated sites
Asst. Prof. Milena Horvat
16. Geochemical comparison of metal fluxes in industrial and volcanic environmental
Dr. Jože Kotnik
17. Identification and remediation of pharmaceutical residues in effluent and surface waters
Dr. Ester Heath
18. Migration of nitrates in the system plant-soil-underground water
Asst. Prof. Sonja Lojen
19. Biological methods for Hg monitoring
Asst. Prof. Milena Horvat
20. Development of tools for management and analysis of the loads and influences on waters in the Sava and Soča catchments
Asst. Prof. Nives Ogrinc
21. The use of new materials from the recycled industrial products and building rubbles in civil engineering
Asst. Prof. Radmila Milačič
22. The determination of the authenticity of wine sugar using a combination of SNIF-NR, IRMS and chemometric methods
Asst. Prof. Nives Ogrinc
23. Food composition tables - meat and meat products
Asst. Prof. Vekoslava Stibilj
24. Nutrition functionality of yeast biomass enriched with iron
Asst. Prof. Nives Ogrinc
25. Monitoring of elements, biophenols and pesticides in olives and in olives oil from Slovene Istra
Asst. Prof. Vekoslava Stibilj
26. Harmonized and safety nutrition
Asst. Prof. Vekoslava Stibilj
27. Recycling and use of waste
Asst. Prof. Milena Horvat

# RESEARCH PROGRAMS

1. Cycling of nutrients and contaminants in the environment, mass balances and modeling of environmental processes and risk analysis
Asst. Prof. Milena Horvat
2. Modeling and environmental impact assessment of processes and energy technologies
Dr. Borut Smodiš

# NEW CONTRACTS

1. Measurements of the radioactivity in the uranium mine environment in the year 2005
Rudnik Žirovski vrh
Dr. Ljudmila Benedik
2. Nitrogen dioxide determination in Slovenia
Ministrstvo za okolje in prostor
Dr. Ester Heath
3. Environmental monitoring in Idrija
Rudnik živega srebra Idrija
Asst. Prof. Milena Horvat
4. Technology platform – information support
Ministrstvo za visoko šolstvo,znanost in tehnologijo
Asst. Prof. Milena Horvat
5. Technical Expertise for evaluation of metal deposition
Ministrstvo za okolje in prostor
Asst. Prof. Zvonka Jeran
6. Safety report for oil-farm at Ortnek
Nafta inženiring Lendava
Asst. Prof. Branko Kontić
7. Threat analysis related to dangerous substances in the municipality of Izola
Občina Izola
Asst. Prof. Branko Kontić
8. Evaluation of measures in the framework of CIVITAS II-MOBILIS Project
Mestna občina Ljubljana
Asst. Prof. Branko Kontić
9. Safety analysis report for Petrol oil reservoirs in Lendava
Petrol, d. d. Ljubljana
Asst. Prof. Branko Kontić
10. Safety analysis report for Nafta Petrochem in Lendava
Nafta Petrochem, d. o. o.
Asst. Prof. Branko Kontić
11. Analyses of drug samples by mass spectrometry
Krka tovarna zdravil, d. d.
Dr. Bogdan Kralj

# VISITORS FROM ABROAD

1. M. Sc. Zora Žunić, Institut za nuklearne nauke, Vinča, Belgrade, Serbia and Montenegro, 19.–21. 1. 2005
2. Dr. Hylke Glass, Camborne School of Mines, Great Britain, 24. 2. 2005
3. Prof. Dr. Kevin Francesconi, Dr. Doris Kuehnelt, University of Graz, Austria, 21.–23. 2. 2005
4. Ausenda Marchado, ITN - Sacavem, Portugal, 31. 1.–12. 2. 2005
5. Soledad Perez Catan, Centro Atomico Bariloche, Rio Negro, Bariloche, Argentina, 23. 1.–12. 2. 2005
6. Igor Čeliković and M. Sc. Zora Žunić, Institut za nuklearne nauke, Vinča, Belgrade, Serbia & Montenegro, 4.–11. 3. 2005
7. Maria Angela de Barros Correa Menezes, Centro de Desenvolvimento da Technologia Nuclear (CDTN), Belo Horizonte, Brazil, 18.–22. 3. 2005
8. Ivana Vukanac, Aleksandar Kandić, Laslo Nadjdjderdj, Institut za nuklearne nauke, Vinča, Serbia & Montenegro, 10.–14. 4. 2005
9. prof. dr. Leon Klasinc, dr. Marko Rožman, Institut Rudjer Bošković, Zagreb, Croatia, 10.–13. 4. 2005
10. Safeer Hussain, IAEA Fellowship, Pakistan Atomic Energy Commission, Nilore, Islamabad, Pakistan, 3.5.–13. 6. 2005
11. Prof. Dr. Leo Klasinc, Institut Rudjer Bošković, Zagreb, Croatia, 3.–5. 5. 2005
12. Dr. Anna Riggio, The National Institute of Oceanography and Applied geophysics – OGS, Trieste, Italy, 16.–25. 5. 2005
13. Mag. Petre Makreski, Univerzitet Sv. Kiril i Metodij, Skopje, Macedonia, 23. 5.–30. 6. 2005
14. Prof. Magda Mandić, Medicinska fakulteta, Rijeka, Croatia, 5.–19. 6. 2005
15. Michael Beeston, University of Exeter, Great Britain, 1. 7.–31. 8. 2005
16. Prof. Fabio Barbone, University of Udine, Italy, 31. 8. 2005
17. Prof. Antonio Sacco, University of Bari, Italy, 4.–6. 7. 2005
18. Prof. Leo Klasinc, Institut Rudjer Bošković, Zagreb, Croatia, 4.–5. 8. 2005
19. Miroslav Simič, Institut za nuklearne nauke, Vinča, Serbia & Montenegro, 16. 8.–7. 9. 2005
20. Dr. Nada Horvatinčič, Laboratorij za merjenje nizkih aktivnosti, Institut Ruđer Bošković, Zagreb, Croatia, 28. 8.–2. 9. 2005
21. Dr. Ryoko Fujiyoshi, Hokkaido University, Graduate School of Engineering, Div. Quantum Science and Engineering, Sapporo, Japan, 31. 8.–29. 9. 2005
22. Dr. Milan Ihnat, Agriculture and Agri-Food Canada, Summerland, Canada, 5.–9. 9. 2005
23. Zorana Ilić, Univerzitet u Sarajevu, Sarajevo, Bosnia and Herzegovina, 12. 9.–12. 12. 2005
24. Stefano Bosisio, Laboratory of Metal Technology, ECAM-Unit JRC-Ispra, Italy, 20.–22. 9. 2005
25. Prof. Dr. Paul Bievre, Institute for Reference Materials and Measurements, European Commission JRC, Geel, Belgium, 29. 9.–6. 10. 2005
26. Dr. Takashi Tomiyasu, National Minamata Institute, dr. Ryusuke Imura, Dr. Akito Matsuyama, Kagoshima University, Japan, 20.–27. 9. 2005
27. Snežana Milošević, Skupština opštine Bujanovac, Vranje, Vinča, Serbia & Montenegro, 23.–28. 9., 9.–11. 10. 2005
28. Sadik Bektesi, Sender Kabashi, University of Priština, 8. - 11. 10. 2005
29. Dr. Jan Kučera, Dr. Jiri Mizera, Academy of Sciences of the Czech Republic, Nuclear Physics Institute, Department of Nuclear Spectroscopy, 15.–21. 10. 2005
30. Dr. Victoria Daskalou, Constantin Stalikas, University of Ioannina, Greece, 22.–28. 10. 2005
31. Zorana Ilić, IAEA Felowship C6/BOH/05004, Zavod za javno zdravstvo, Bosnia and Hercegovina, Centar za zaštitu od zračenja, Sarajevo, Bosnia and Herzegovina, 12. 9.–12. 10. 2005
32. Prof. Dr. Leo Klasinc, Institut Rudjer Bošković, Zagreb, Croatia, 15.–18. 11. 2005
33. Milena Taseska, Univerzitet Sv. Kiril i Metodij, Skopje, Macedonia, 27. 11.–23. 12. 2005
34. Hylke Glass, Camborne School of Mines, Camborne, Great Britain, 19.–21. 12. 2005
35. Dr. Stefan Bossisio, Prof. Enrico Sabbione, European Commission, ECVAM Unit, Institute for Health and Consumer Protection (IHCP), Joint Research Centre (JRC), Ispra, Italy, 7.–8. 12. 2005
36. Prof. Gaetane Lespes, Université de Pau et des Pays de l'Adour, Laboratoire de Chimie Analytique, Bio-Inorganique et Environnement-UMR CNRS 5034- France, 22. 12. 2005

# STAFF

**Researchers**

1. Dr. Ljudmila Benedik
2. Prof. Tadej Dolenec*
3. Dr. Ingrid Falnoga
4. **Prof. Milena Horvat**, Head**
5. Dr. Radojko Jaćimović
6. Asst. Prof. Zvonka Jeran
7. Prof. Ivan Kobal
8. Dr. Bogdan Kralj
9. Asst. Prof. Sonja Lojen
10. Asst. Prof. Radmila Milačič**
11. Dr. Nives Ogrinc**
12. Dr. Arkadije Popovič
13. Dr. Borut Smodiš
14. Asst. Prof. Vekoslava Stibilj
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16. Dr. Zdenka Šlejkovec
17. Asst. Prof. Janja Vaupotič**
18. Dr. Dušan Žigon

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19. Dr. Ester Heath
20. Dr. Jože Kotnik
21. *Dr. Jasmina Kožar Logar, left 30. 6. 2005*
22. *Dr. Martina Logar, left 15. 2. 2005*
23. Dr. Polona Tavčar
24. Dr. Polona Vreča
25. Dr. Boris Zmazek***

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26. Tinkara Bučar, B. Sc.
27. Petra Cuderman, B. Sc.
28. Darija Gibičar, B. Sc.
29. Rožle Jakopič, B. Sc.
30. Tjaša Kanduč, M. Sc.
31. David Kocman, B. Sc.
32. Davor Kontić, B. Sc.
33. Blaž Kralj, B. Sc.
34. Dr. Darja Mazej
35. Tadeja Milivojevič Nemanič, B. Sc.
36. Tanja Mrak, B. Sc.
37. Simona Murko, B. Sc.
38. Nataša Nolde, M. Sc.
39. Andrej Osterc, B. Sc.
40. Urška Repinc, B. Sc.
41. *Dr. Polona Smrkolj, left 19. 9. 2005*
42. Špela Uršej, B. Sc.
43. Tea Zuliani, B. Sc.
44. Mladen Živčić***, M. Sc.
45. Suzana Žižek, B. Sc.

**Technical officers**

46. *Nuša Horvat, left 1. 9. 2005*
47. Asst. Prof. Branko Kontić**
48. Dr. Svetozar Polič

**Technical and administrative staff**

49. Petra Dujmović
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51. Barbara Korc
52. Silva Perko
53. Janja Smrke
54. Barbara Svetek
55. Zdenka Trkov
56. Stojan Žigon

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

# DEPARTMENT OF AUTOMATION, BIOCYBERNETICS AND ROBOTICS E-1

***Our research brings together different fields of automatics, robotics, biocybernetics, kinesiology and environmental medicine. Most of the research topics are connected to the so-called "movement of man and machine" and its connection and interaction with the environment. The aim is to make advanced knowledge available by developing and transferring systems and technologies to our customers in industry, medicine and sports.***

Head:
***Dr. Leon Žlajpah***

The main directions of research in the last year were humanoid robotics, the integration of mobility and manipulation in industrial and service robotics, studies of human physiology in extreme environments, evaluation of protective equipment, development of biomedical devices and methods, and the robotics and automation of industrial manufacturing.

We performed different measurements of the shoulder complex and developed a kinematic model, which includes four degrees of freedom in the shoulder girdle and three degrees of freedom in the glenohumeral joint. We developed a new kinematic model that incorporates mathematical interdependencies between joint angles. We proposed a model composed of inner joint (joint of the shoulder girdle) and outer joint (glenohumeral joint), which will be used as the basis for the development of a human arm. We continued our research on the energy efficient motion of human and robot mechanisms. We upgraded the study of human vertical jumping, developed a mathematical model of the robotic jumper, and constructed an environment for the simulation of various movements. By means of a mathematical model and simulations we concluded that we can build an autonomous human inspired mechanism with the existing technology that will be able to perform fast movements. We have begun to construct a humanoid robotic mechanism with which we would like to perform human-like explosive movements such as vertical jump, long jump, and running.

**We have developed a new method for controlling the humanoid robot's oculomotor system, imitating humanoid vision (higher resolution in the eye centre and lower on the edge).**
**Automation of production lines have increased the productivity and decreased the price of the product.**

In the field of robot control we have addressed the problem of controlling a mobile manipulator. We have developed a new type of control, suitable for controlling redundant systems composed of two or more subsystems, where one part of the system is controlled by torque and the other by velocity. Using suitable sensor systems this control strategy enables collision-free motion in an unstructured environment. The combined control was mathematically analyzed and we have shown that although the velocity controller was used to control the mobile platform, the combined control gives results comparable to the results of complete torque control. The proposed control strategy was tested on a real mobile manipulator.

The development of humanoid robotic systems is an important part of our research. In the past year we developed new techniques for the identification of potential objects of interest with a humanoid robot vision system. We started from a biologically motivated visual attention theory and implemented it on a computer cluster consisting of eight workstations. The visual processing was integrated with the humanoid robot's oculomotor system, which enabled the robot to direct its gaze towards potential objects of interest. This research was done in collaboration with ATR Computational Neuroscience Laboratories, Kyoto, Japan, in the frame of the joint research project titled "Learning object-action descriptions and active object recognition by a humanoid with foveated vision".

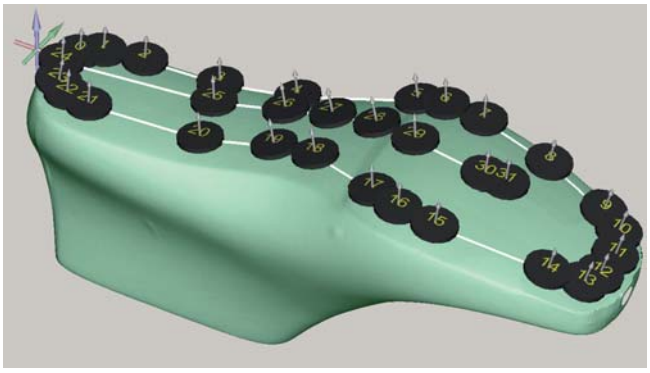

*Figure 1: Automatic robot trajectory generation based on shoe last CAD models*

We have collaborated with the Alpina factory for several years. In 2005, we implemented a new robotized cell for distributing glue to the sole of a shoe. To control the cell an advanced controller is used together with different sensors. The robot trajectories are generated automatically based on the CAD models of the shoe lasts. Together with the company Droga-Kolinska we continued our research and development activities on the advanced tea production line. We determined the logical, hardware, and software structure of a supervisory and control system for the plant. The implementation of these will result in a completely automated production line, tightly integrated with the manufacturing and enterprise resource planning levels. Our solution will enable the concurrent production of a number of different tea blends, packaged in different

*Figure 2: Experimental exercise test of the COPD patient using the opto-electronic measurement system*

*Figure 3: Evaluation of military protective equipment in winter*

container formats, while the investment costs will be considerable lower than for a solution with a number of separate, single product, production lines. Thus, this research and development project will economically benefit the target factory as well as the Slovenian economy.

This year we have inaugurated the laboratory for environmental ergonomics, which allows us to evaluate human performance and protective equipment in a wide range of ambient conditions. Our climatic chamber can simulate ambient temperatures from -30° to +50°C and altitudes up to 15,000 m. The hyperbaric chamber has an operating pressure of 8 ATA, which allows simulation of hyperbaric environments equivalent to a depth of 70 msw. In addition to conducting human experiments in these facilities, we conduct testing of footwear and clothing with our sweating thermal foot manikin and immersion thermal manikin, respectively. Much of our work in the past year has focused on evaluating the summer and winter protective clothing of the Slovene Armed Forces. Field studies were conducted in the Alpine training facility at Pokljuka and at the Naval Base in Ankaran. Based on the results of these field trials, Alpina d.d. developed a hiking boot which is currently undergoing further testing. We have also assisted W.L. Gore & Associates (USA) in evaluating several exciting ideas concerned with increasing wearer comfort. With colleagues from the Swedish Defence Research Establishment we continue to investigate the deleterious effects of motion sickness, and among others have demonstrated that it decreases G-tolerance. We are also collaborating with the Institute of Naval Medicine (UK) is establishing new fitness standards for military divers. Members of the Slovene Armed Forces Diving Unit are also involved in this study. For the purpose of testing the aerobic capacity of divers underwater, we have designed and built an underwater swimming ergometer for the Institute of Naval Medicine (UK). With colleagues from Dalhousie University (Canada) we investigated the possibility of harnessing the response of cold-induced vasoconstriction in preventing cold injuries to the digits of the hands and feet.

**Our new laboratory makes it possible to evaluate human performance and to test protective equipment in a wide range of ambient conditions. Testing of footwear with our sweating thermal foot manikins helped to develop new high-quality shoes with increased wearer comfort.**

In the EU project CARED (Computer Aided Rehabilitation of Respiratory Disabilities) physiotherapeutic control of expiratory muscle recruitment possibilities were examined in patients with COPD (Chronic Obstructive Pulmonary Disease). The main objective was to investigate the abdominal muscles breathing activity (EMG) during exercise testing (cycloergometry) and the effect of high-frequency electrical stimulation on muscle fatigue. A disadvantage of abdominal expiratory muscle recruitment during exercise is a diminution of venous return and therefore lower cardiac output. The consequence of the latter can be a reduced

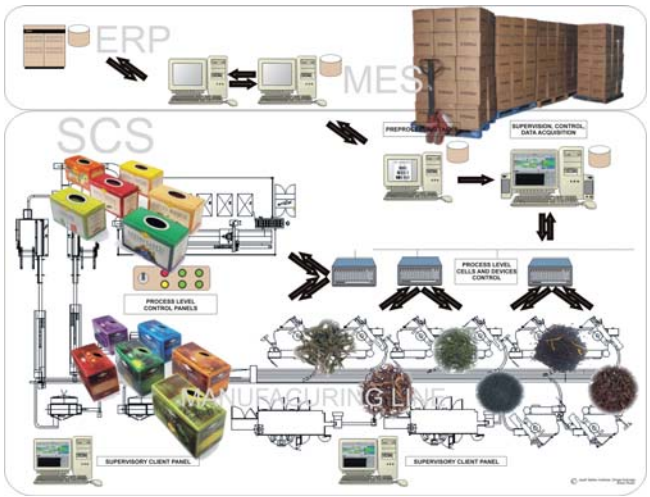


*Figure 4: Control and supervisory system of the tea production line in the factory Droga-Kolinska*

*Figure 5: Climatic chamber in a new laboratory for environmental ergonomy*

exercise tolerance. The periodic abdominal muscle breathing activity - exercise load relationship and the phenomenon threshold were discovered. Results will be used for bio-feedback and relaxation or blocking of abdominal muscles during breathing. The research was done in cooperation with the Clinic of Respiratory and Allergic Diseases, Golnik, Slovenia.

During the past year we studied human body movement during sports activities. The research was focused on alpine skiing. We proposed energy dissipation criteria for estimation of the quality of the ski turns. In cooperation with the Faculty of Sports, Ljubljana, we developed a software package which estimates the quality of ski turns using previously measured skier kinematic and dynamic parameters. We developed the methodology for the estimation of the quality of the ski plates using an industrial robot and accomplished a comparative study of more than 30 ski-plates.

### Some outstanding publications in the past three years


1. Lenarcic J., Stanisic M., A humanoid shoulder complex and the humeral pointing kinematics, IEEE Transactions on Robotics and Automation, 19 (2003) 3, 499-506
2. Žlajpah, L., Nemec, B., Force strategies for on-line obstacle avoidance for redundant manipulators. Robotica, 21 (2003) , 633-644.
3. Gaskett, C., Ude, A., Cheng, G., Hand-eye coordination through endpoint closed-loop and learned endpoint open-loop visual servo control. International journal of humanoid robotics, 2 (2005), 203-224
4. Mekjavić, I.B., Golja, P., Tipton, M.J., Human thermoregulatory function during exercise and immersion after 35 days of horizontal bed-rest and recovery, European journal of applied physiology, 95 (2005), 163-171.
5. O. Eiken and I. Mekjavič, Ischaemia in working muscles potentiates the exercise-induced sweating response in man. Acta Physiol. Scand. (2004), 305–311


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## ORIGINAL ARTICLES


1. Ola Eiken, Michael J. Tipton, Roger Kölegard, Bertil Lindborg, Igor B. Mekjavić: Motion sickness decreases arterial pressure and therefore acceleration tolerance. Aviat. space environ. med., Vol. 76, pp. 541-546, 2005.
2. Chris Gaskett, Aleš Ude, Gordon Cheng: Hand-eye coordination through endpoint closed-loop and learned endpoint open-loop visual servo control. International journal of humanoid robotics, Vol. 2, pp. 203-224, 2005.
3. Petra Golja, Alan Kacin, Michael J. Tipton, Igor B. Mekjavić: Moderate hypoxia does not affect the zone of thermal comfort in humans. Eur. j. appl. physiol. occup. physiol., Vol. 93, pp. 708-713, 2005.
4. Alan Kacin, Petra Golja, Ola Eiken, Michael J. Tipton, Jurij Gorjanc, Igor B. Mekjavić: Human temperature regulation during cycling with moderate leg ischaemia. European journal of applied physiology, Vol. 95, pp. 213-220, 2005.
5. Nives Klopčar, Jadran Lenarčič: Kinematic model for determination of human arm reachable workspace. Meccanica, Vol. 40, pp. 203-219, 2005.
6. Jadran Lenarčič, Nives Klopčar: Positional kinematics of humanoid arms. Robotica, Vol. 24, pp. 105-112, 2005.
7. Igor B. Mekjavić, Petra Golja, Michael J. Tipton: Human thermoregulatory function during exercise and immersion after 35 days of horizontal bed-rest and recovery. European journal of applied physiology, Vol. 95, pp. 163-171, 2005.
8. Leon Lahajnar, Leon Žlajpah: Vodenje robota na temelju zaznaval sile in računalniškega vida. Stroj. vestn., Letn. 51, No. 11, pp. 724-736, 2005.


## PUBLISHED CONFERENCE PAPERS

### Regular Papers


1. Jan Babič, Damir Omrčen: Optimal triceps surae muscle-tendon stiffness for jumping. 6th International Symposium on Computer Methods in Biomechanics & Biomedical Engineering: February 25-28, 2004, Madrid, Spain, John Middleton, ed., Nigel Shrive, ed., Malcolm Jones, ed., Cardiff, FIRST Numerics, 2005, 6 pp.
2. Tomaž Berlec, Janez Kušar, Ladislav Lenart, Marko Starbek: Hidden logistic potentials in the company. SOR '05 proceedings, The 8th International Symposium on Operational Research in Slovenia, Nova Gorica, Slovenia, September 28-30, 2005, Lidija Zadnik Stirn, ed., Samo Drobne, ed., Ljubljana, Slovenian Society Informatika (SDI), Section for Operational Research (SOR), 2005, pp. 193-198.
3. Andrej Gams: Robotizirana obdelava surovih ulitkov. Avtomatizacija v industriji in gospodarstvu: zbornik četrte konference AIG'05, 7. in 8. april 2005, Maribor, Slovenija, Boris Tovornik, ed., Nenad Muškinja, ed., [Maribor], Društvo avtomatikov Slovenije, 2005, pp. 129-133.
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6. Nina Kocjan, Ola Eiken, Igor B. Mekjavić: Cutaneous temperature sensitivity and the thermal comfort zone across the menstrual cycle. Environmental ergonomics XI: proceedings of the 11th International Conference, 22-26 May, 2005 Ystad, Sweden, [Sweden], Lund University, 2005, pp. 155-157.
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8. Leon Lahajnar, Leon Žlajpah: Sledenje krivulji na osnovi senzorja sile in računalniškega vida. Zbornik štirinajste mednarodne Elektrotehniške in računalniške konference ERK 2005, 26. - 28. september 2005, Portorož, Slovenija(Zbornik... Elektrotehniške in računalniške konference ERK...), Baldomir Zajc, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2005, Zv. B, pp. 157-160.
9. Ladislav Lenart, Jan Babič: Optimalna kontrola dinamičnega sistema z uporabo algoritmov najkrajše poti. Informatika kot temelj povezovanja: zbornik posvetovanja, DSI - Dnevi slovenske informatike 2005, Portorož, Slovenija, 13.-15. april, Aleksander Novaković, ed., Niko Schlamberger, ed., Mojca Indihar Štemberger, ed., Martina Učak, ed., Janja Drole, ed., Ljubljana, Slovensko društvo Informatika, = Slovenian Society Informatika, 2005, pp. 478-483.
10. Ladislav Lenart, Jan Babič: Uporaba algoritmov najkrajše poti pri kontroli dinamičnih sistemov. 10. seminar o procesni metalurgiji jekla, Jakob Lamut, ed., Ljubljana, NTF, Odd. za mat. in tehnologijo, 2005, 6 pp.
11. Ladislav Lenart, Jan Babič: Dynamic programming in control. SOR '05 proceedings, The 8th International Symposium on Operational Research in Slovenia, Nova Gorica, Slovenia, September 28-30, 2005, Lidija Zadnik Stirn, ed., Samo Drobne, ed., Ljubljana, Slovenian Society Informatika (SDI), Section for Operational Research (SOR), 2005, pp. 63-68.
12. Igor B. Mekjavić, Bojan Andlovec Korošec, Martin Tomšič, Petra Golja: Phase change material in hiking boots does not minimise the risk of cold injury. Environmental ergonomics XI: proceedings of the 11th International Conference, 22-26 May, 2005 Ystad, Sweden, [Sweden], Lund University, 2005, pp. 135-136.
13. Igor B. Mekjavić, Bojan Andlovec Korošec, Martin Tomšič, Petra Golja: Phase change material in hiking boots does not minimise the risk of cold injury. Prevention of cold

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24. Matej Supej, Otmar Kugovnik, Bojan Nemec: Advanced analysis of alpine skiing based on 3D kinematic measurements. Science and skiing III, [the Third International Congress on Skiing and Science, Snowmass at Aspen, CO, USA, March 28 - April 3, 2004], Erich Müller, ed., David Bacharach, ed., Riggs Klika, ed., Stefan Lindinger, ed., Hermann Schwameder, ed., Oxford, Meyer & Meyer Sport, cop. 2005, pp. 216-227.
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## THESES

### Ph. D. Theses

1. Nives Klopčar: Kinematic model of human shoulder complex and reachable workspace of human arm (Prof. Jadran Lenarčič)
2. Damir Omrčen: Combined velocity and torque control of a mobile manipulator (Prof. Jadran Lenarčič)

### B. Sc. Thesis

1. Mirnesa Smolej: Effects of bedrest on heart rabe variability (Dr. Miroljub Jakovljevič, comentor: Dr. Martin Tomšič)

## INTERNATIONAL PROJECTS

1. Evropska mreža odličnosti
   EURON; 6. FP; 507728
   EC; Kungliga Tekniska Högskolan, Stockholm, Sweden
   Prof. Jadran Lenarčič
2. Computer Aided Rehabilitation of Respiratory Disabilities
   CARED; 5. FP; QLG5-CT-2002-00893
   EC; Prof. Adriano Demaio, Prof. Antonio Pedotti, Dipartimento di Bioingegneria, Polytechnic of Milan, Milano, Italy
   Dr. Martin Tomšič
3. Hyperbaric Oxygen Therapy
   COST B14; EC
   Dr. Igor Mekjavič
4. Multiple Features Encoding for Distributed Video-based Motion Capture
   dr. Mitsuo Kawato, Toyoko Morihisa, Advanced Telecommunications Research Institute International, Computational Neuroscience Laboratories, Kyoto, Japan
   Dr. Ude Aleš
5. Learning Object-action Descriptions and Active Object Recognition by a Humanoid with Foveated Vision
   SLO-JPN
   Prof. Cheng Gordon, ATR, Computational Neuroscience Laboratories, Department of Humanoid Robotics and Computational Neuroscience, Kyoto, Japan
   Dr. Aleš Ude
6. Footwear Ventilation
   Mark K. Newton, W. I. Gore & Associates, Inc., Elkton, MO, USA
   Bogomir Vrhovec

## R & D GRANTS AND CONTRACTS

1. Cellular Chips
   Bogomir Vrhovec, B. Sc.
2. Development of technology and methodology for complete restoration of learning of walking
   Prof. Jadran Lenarčič
3. System for automatic supervision and control of a production line for simultaneous production of different products
   Dr. Aleš Ude
4. Integration of CAD systems into shoe assembly production processes
   Dr. Leon Žlajpah
5. Development and optimisation of military personal protective equipment
   Prof. Igor Mekjavič

## RESEARCH PROGRAM

1. Automation, robotics and biocybernetics
   Prof. Jadran Lenarčič

## NEW CONTRACTS

1. Cofinancing of COST and NATO projects
   Javna agencija za raziskovalno dejavnost RS
   Prof. Jadran Lenarčič
2. Programming system for coding, marking and labeling in a fully automated packaging line
   Droga Portorož
   Dr. Anton Ružič
3. High altitude simulation system
   Kolesarski klub Krka
   Vrhovec Bogomir, B. Sc.

# VISITORS FROM ABROAD

1. Dr. Volkmar Bartels, Hohenstein Institutes, Boennigheim, Germany, 2 days in April 2005
2. Antonio Caputi, University of Bologna, Italy, Jun 1st.–30th, 2005
3. Dr. Stephen S. Cheung, School of Health and Human Performance, Dalhousie University, Halifax, New Scotland, Canada, U.S.A., July 2nd–5th, 2005
4. Dr. Jurij Zupan, Minister of Higher Education, Science and Technology RS, July 6th 2005
5. Carol House, Environmental Medicine Unit, Institute of Naval Medicine, Gosport, United Kingdom, 1 week in September, 2005
6. Mark Newton, W.L. Gore & Associates, USA, at 2-3 days each time in August and October, 2005
7. Dr. Janez Potočnik, European Commisioner for Science and Research, October 10th, 2005
8. Prof. Olla Eiken, Swedish Defence Research Establishment, Karolinska Institutet, Stockholm, Sweden, 2 weeks in October, 2005
9. Christian Bier, W.L. Gore & Associates, Germany, 1 day in November, 2005
10. Bernard Redotier, Decathlon, France, 2 days in November, 2005
11. Sabrina Langerholz, W.L. Gore & Associates, Germany, 1 week in August and 1 week in November, 2005
12. Niels C.P. Bogerd, M. Sc., EMPA (Swiss Federal Institute for Materials Science and Technology; Laboratory for Protection and Physiology), St. Gallen, Switzerland, 1 day in November, 2005
13. Participants of EURON Board Meeting, November 11th and 12th, 2005
14. Stelios Kounalakis, Department of Sports Medicine & Biology of Exercise, Faculty of Physical Education and Sport Science, University of Athens, Greece, November 20th-30th, 2005
15. Prof. Andrew Blaza, Imperial College, London, Great Britain, November 22nd, 2005
16. Adi Rosenfeld, Honorary Consul of the Republic of Slovenia in Israel, 28.11.2005
17. The visit of the Cypriot Researchers: Dr. Andreas Hadjisavva, Cyprus Institute of Neurology and Genetics, Dr. George Georgiades , GG Dedalos Technology Services, Dr. Andreas Kyprianou, University of Cyprus, Mechanical and Engineering Department, Dr. Antonis Londos, Frederick Institute of Technology, Mechanical Engineering, Dr. Vasilis Promponas, University of Cyprus, Department of Biological Sciences, Dr. Rebecca Kokkinofta, State General Laboratory, Peter Volasko, M. Sc., ARRS, December 12th, 2005
18. Prof. Nickos Geladas, Department of Sports Medicine & Biology of Exercise Faculty of Physical Education and Sport Science University of Athens, Greece, 1 week in December, 2005
19. Dr. Maria D. Koskolou, Department of Sports Medicine & Biology of Exercise Faculty of Physical Education and Sport Science, University of Athens, Athens, Greece, 1 week in December, 2005
20. Prof. Nigel Taylor, Department of Biomedical Sciences, University of Wollongong, Wollongong, NSW, Australia, 5 days in December 2005
21. Ladislav Lipič, General Major, Slovene Armed Forces and Matjaž Žirovnik, Major, Slovene Armed Forces, December 5th, 2005

# STAFF

**Researchers**

1. Prof. Igor Mekjavić**
2. Dr. Bojan Nemec
3. Dr. Aleš Ude
4. **Dr. Leon Žlajpah, Head**

**Postdoctoral associates**

5. Dr. Jan Babič
6. Dr. Damir Omrčen
7. Dr. Martin Tomšič

**Postgraduates**

8. Mitja Babič
9. Andrej Gams
10. Leon Lahajnar

**Technical officers**

11. Nina Kocjan
12. Borut Lenart
13. Dr. Ladislav Lenart
14. Dr. Anton Ružić
15. *Danijel Šlebinger, left September 1st, 2005*
16. Bogomir Vrhovec

**Technical and administrative staff**

17. Dušan Filipič
18. Jožef Opeka
19. Marija Trampuž
20. Janez Zalar

** Part-time faculty member

# DEPARTMENT OF SYSTEMS AND CONTROL E-2

***The Department of Systems and Control is engaged in research, development, applications, and education across various areas of control technology. Its mission is 'to bridge the gap between theory and practice'. Hence, the research activities are rather application oriented, and the work is closely related to the needs of production companies. The activities of the department are focused on four closely integrated targets: basic and applied research, R&D projects for industrial and other users, education and training of engineers, and the networking and integration of Slovenian institutions and companies dealing with control technology.***

Head:
***Prof. Stanislav Strmčnik***

**The Department of Systems and Control is engaged in research, development, applications and education across various areas of control technology.**
**Research within this area during the year 2005 was devoted to three sub-areas: analysis and control of complex systems and processes, fault detection and isolation, and computer-integrated production control.**

### Basic and applied research

Research within this area during the year 2005 was devoted to three sub-areas: analysis and control of complex systems and processes, fault detection and isolation, and computer-integrated production control.

The aim of research in the sub-area **analysis and control of complex systems and processes** was to improve existing and develop new algorithms for systems or process control. Here, the emphasis of our work was to develop new approaches in experimental modelling of linear and nonlinear systems based on identification by Gaussian processes, to develop methods for control design based on identification with multimodel algorithms, to optimise tuning algorithms for industrial controllers, and to apply control algorithms in stereoscopy. Part of our work was also devoted to validation of procedures for control design and modelling of waste-water treatment plants and in production of electric motors.

Nowadays, continuous quality control in manufacturing as well as in the processing industries and other high-technology systems has become standard in helping to better productivity and competitiveness. Therefore, **fault detection and isolation** is currently a fast developing sub-area of research in the Department of Systems and Control of increasing significance for our industrial partners. In the year 2005, our research on robust fault detection in control actuators with consideration of model error was continued. In addition, some work was done on robust fault detection of nonlinear systems. A thorough industrial case study done in our laboratory has revealed that invented fault detection procedures allow reliable isolation of faults in the production of household vacuum cleaner-motors. These new procedures also offer high diagnostic sensitivity and precision in isolating mechanical problems in these products. On the basis of our acquired knowledge and experience, we were able to construct a universal systems concept for automatic online supervision of production processes and product quality (Fig. 1).

Our research in **computer-integrated production control** is aimed at enhancing existing manufacturing information and execution systems (MES) with functions for efficient decision-making. In 2005, a procedural model was developed for a selected manufacturing system. The new model is designed as a functional building block of MES, supporting decision-making, which will use technology as well as production cost parameters to help production managers in optimising efficient closed-loop production control (Fig. 2).

The second research topic within this sub-area was modelling the process of polymerisation using the modelling tool "gPROMS". The aim of this modelling effort was to improve the production technology and the production control procedures. The third topic led to the design of a flexible recipe management and control system for use with industrial programmable controllers. Our work on the fourth research topic within the sub-area computer-integrated production control resulted in improved methods for design and evaluation of human-centred technology.

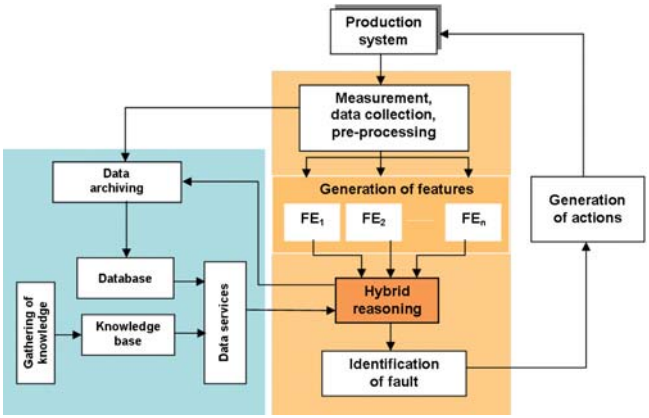


*Figure 1: Structure of the system for online process supervision and quality control in manufacturing and processing industries.*

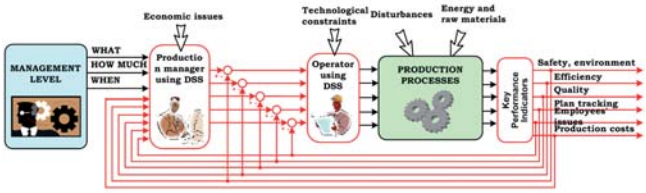


*Figure 2: Outline of a system for decision support (DSS) in production control based on key performance indicators.*

### R&D projects for industry and other users

In 2005, our long term cooperation with the engineering company **INEA** has been continued with adaptation and integration of some existing and some newly developed advanced control devices for industrial applications. In addition to this, a simplified software package was developed for INEA, intended for batch control with programmable controllers according to batch control standard S88. For the company **GOAP** from Nova Gorica which designs advanced climatisation control systems for buildings, further strategies and procedures for optimal climatisation control were developed at our department., Work was continued with the company **DOMEL** from Železniki on the development of control devices and procedures aimed at preventive fault diagnosis and isolation in the production of household vacuum-cleaner motors (Fig. 3). For the same company, industrial prototype devices and a patented method were developed for the analysis of sparking in universal commutator electric motors.

Researchers from our department are cooperating for more than two decades with the development team at the Chemical Works Cinkarna Celje on improving control procedures and process control equipment in the production of titanium dioxide. During the year 2005, they developed algorithms for pH control and for smoothing the peaks in steam consumption. For the pharmaceutical company LEK, improved algorithms for controller tuning have been developed and validated at their production site in Mengeš near Ljubljana (Fig. 4). At the subsidiary of the company Danfoss in Ljubljana, a complete control system (including hardware, control procedures and software) was developed by our department. The new control system helps to manage a complex semi-industrial setup for systematic functional testing of the elements needed for building heating and climatisation (Fig 5). In addition to the projects mentioned above, part of our work was devoted to smaller projects, such as functional specifications for automatic control of a pharmaceutical plant, and improvement of batch control procedures, both for the company Metronik.

**In the company DOMEL from Železniki, work was continued on the development of control devices and procedures aimed at preventive fault diagnosis and isolation for the production of household vacuum cleaner motors (Fig. 3).**


*Figure 3: System for automatic final quality control of vacuum cleaner motors in the company Domel, Železniki, Slovenia.*

### Education and training activities

Some members of the department are giving lectures and practical courses at the Faculty of Electrical Engineering, University of Ljubljana, the Polytechnic of Nova Gorica, and the "Jožef Stefan" International Postgraduate School. They also act as supervisors of M.Sc and Ph.D. students. Special care was dedicated to post-qualification training for engineers from industry. In 2004, three one-week courses were organized. These courses were organized in close co-operation with the Information Technologies Knowledge Transfer Center at the Jozef Stefan Institute.

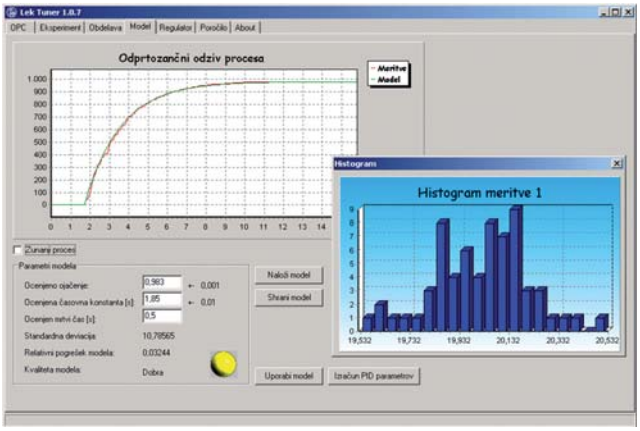


*Figure 4: Monitor display generated by the software for automatic controller tuning developed for the pharmaceutical company LEK, Slovenia.*

### Integration of Slovenian institutions and companies dealing with control technology

Members of the Department of Systems and Control play one of the key roles in the management, professional, and organisational coordination of the technology network called "Process control technology", together with its research and application projects. This technology network integrates eleven companies (who are suppliers of either control technology services or control equipment) and three R&D or education/training institutions. The technology network and its projects are co-financed by the European Regional Development Fund. One of these projects, managed by our department, aims at establishing the Centre of Excellence for Advanced Control Technologies in Slovenia.

## Some outstanding publications in the past three years

1. Dolanc, Gregor, Strmčnik, Stanko. Identification of nonlinear system using a piecewise-linear Hammerstein model. Syst. control. lett.. [Print ed.], 2005, vol. 54, str. 145-158.
2. Hvala, Nadja, Strmčnik, Stanko, Šel, Davorka, Milanič, Srečko, Banko, Blaže. Influence of model validation on proper selection of process models - an industrial case study. Comput. chem. eng.. [Print ed.], 2005, vol. 29, str. 1507-1522.
3. Benko, Uroš, Petrovčič, Janko, Juričić, Đani, Tavčar, Jože, Rejec, Jožica. An approach to fault diagnosis of vacuum cleaner motors based on sound analysis. Mech. syst. signal process., 2005, vol. 19, str. 427-445.

## The most important technological achievements in the past three years

1. A control system for magneto-focused plasma annealer (Gregor Dolanc, Samo Gerkšič)
2. A system for quality control of vacuum cleaner motors (Janko Petrovčič, Gregor Dolanc, Bojan Musizza, Đani Juričić, Dejan Tinta, Uroš Benko, Janez Grom, Miro Štrubelj)

## Awards and appointments

1. Janko Petrovčič, Gregor Dolanc, Bojan Musizza in cooperation with team members of the company Domel, Železniki: The Golden Award for Innovations 2004 awarded by The Chamber of Economy of Gorenjska Region awarded. The aim of this award is to strenghten the competitivness of industry in Gorenjska region with the promotion of innovation activities, Kranj, 14. 6. 2005

## Organization of conferences, congresses and meetings

1. Information Technologies & Control: Young Generation Viewpoint: 6th International PhD Workshop, Izola, October 4 – 8, 2005
2. Production management and information systems: continuing education (specialisation) course in Control Technology, Ljubljana, January 31 – February 4, 2005
3. Automation and information technology projects: continuing education (specialisation) course in Control Technology, Ljubljana, April 18-22, 2005
4. Building blocks for computer automation: continuing education (specialisation) course in Control Technology, Ljubljana, October, 17-21, 2005

*Figure 5. Semi-industrial setup for systematic functional testing of elements needed in the heating and climatisation of buildings. The control system for the setup shown here was developed by the Department of Systems and Control.*

**Members of the Department of Systems and Control, Janko Petrovčič, PhD, Gregor Dolanc, PhD, and Bojan Musizza, together with the leading engineers from company DOMEL were awarded by the Slovenian Chamber of Economy, Regional Chamber for Gorenjska, Kranj, with the 'Golden Award for Innovation'.**

**Members of the Department of Systems and Control play one of the key roles in the management, professional, and organisational coordination of the technology network called "Process control technology"**

# BIBLIOGRAPHY

## ORIGINAL ARTICLES


1. Uroš Benko, Janko Petrovčič, Đani Juričić, Jože Tavčar, Jožica Rejec: An approach to fault diagnosis of vacuum cleaner motors based on sound analysis. Mech. syst. signal process., Vol. 19, pp. 427-445, 2005.
2. Gregor Dolanc, Stanko Strmčnik: Identification of nonlinear system using a piecewise-linear Hammerstein model. Syst. control. lett., Vol. 54, pp. 145-158, 2005.
3. Nadja Hvala, Stanko Strmčnik, Davorka Šel, Srečko Milanič, Blaže Banko: Influence of model validation on proper selection of process models - an industrial case study. Comput. chem. eng., Vol. 29, pp. 1507-1522, 2005.
4. Juš Kocijan, Agathe Girard, Blaže Banko, Roderick Murray-Smith: Dynamic systems identification with Gaussian processes. Math. comput. model. dyn. syst., Vol. 11, Vol. 4, pp. 411-424, 2005.
5. Aljaž Stare, Nadja Hvala, Darko Vrečko: Modeliranje in validacija poenostavljenega modela za prediktivno vodenje amonijevega dušika v čistilni napravi odpadnih voda. Elektroteh. vestn., Vol. 72, pp. 225-230, 2005.
6. Dejan Tinta, Janko Petrovčič, Uroš Benko, Đani Juričić, Andrej Rakar, Mina Žele, Jože Tavčar, Jožica Rejec, Aneta Stefanovska: Fault diagnosis of vacuum cleaner motors. Control Engineering Practice, Vol. 13, pp. 177-187, 2005.
7. Mina Žele, Đani Juričić: Estimation of the confidence limits for the quadratic forms in normal variables using a simple Gaussian distribution approximation. Comput. stat. (Z.), Vol. 20, pp. 137-150, 2005.
8. Mina Žele, Darko Vrečko, Đani Juričić: Spremljanje delovanja senzorjev v čistilni napravi odpadnih voda z uporabo adaptivne metode glavnih komponent. Ventil (Ljubl.), Letn. 11, No. 2, pp. 84-88, 2005.

9. Robert Blatnik, Janko Černetič: Vrednotenje antropocentričnosti računalniške podpore dobavljanja sestavnih delov. Organizacija (Kranj), Let. 38, No. 5, pp. 225-231, 2005.

## REVIEW ARTICLES AND CHAPTERS IN BOOKS

1. Juš Kocijan, Roderick Murray-Smith: Nonlinear predictive control with a Gaussian process model. Switching and learning in feedback systems: European Summer School on Multi-Agent Control, Maynooth, Ireland, September 8-10, 2003: revised lectures and selected papers(Lecture notes in computer science, vol. 3355), Roderick Murray-Smith, ed., Robert Shorten, ed., Berlin, Heidelberg, New York, Springer, cop. 2005, pp. 185-200.

## PUBLISHED CONFERENCE PAPERS

### Invited Paper

1. Andriy Bandrivskyy, M. Entwistle, P. V. E. McClintock, Bojan Musizza, Milan Paluš, Janko Petrovčič, Samo Ribarič, A. Smith, Aneta Stefanovska: Stochastic dynamics of anasthesia, pp. 553-558.

### Regular Papers

1. Kristjan Ažman: Incorporating prior knowledge into Gaussian process models. Proceedings of the 6th International PhD Workshop on Systems and Control, October 4-8, 2005, Izola, Simonov zaliv, Slovenia: young generation viewpoint, Dejan Tinta, ed., Uroš Benko, ed., Ljubljana, Institut Jožef Stefan, 2005, 6 pp.
2. Kristjan Ažman, Juš Kocijan: Comprising prior knowledge in dynamic Gaussian process models. CompSysTech'05: proceedings of the International Conference on Computer Systems and Technologies and Workshop for PhD Students in Computing: Varna, Bulgaria, 16-17 June, B. Rachev, ed., A. Smrikarov, ed., [Varna], Bulgarian Chapter of ACM, 2005, pp. IIIB.2-1-IIIB.2-5.
3. Kristjan Ažman, Juš Kocijan: An example of Gaussian process model identification. MIPRO 2005: 28. međunarodni skup, May/Svibanj 30 - June/Lipanj 03, 2005, Opatija, Croatia: Proceedings/Zbornik radova, Leo Budin, ed., Slobodan Ribarić, ed., Rijeka, MIPRO, 2005, pp. 79-84.
4. Kristjan Ažman, Juš Kocijan: Identifikacija dinamičnega sistema s histerezo z modelom na osnovi Gaussovih procesov. Zbornik štirinajste mednarodne Elektrotehniške in računalniške konference ERK 2005, 26. - 28. september 2005, Portorož, Slovenija(Zbornik... Elektrotehniške in računalniške konference ERK...), Baldomir Zajc, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2005, Zv. A, pp. 253-256.
5. Uroš Benko, Janko Petrovčič, Đani Juričić: In-depth fault diagnosis of small universal motors based on acoustic analysis. Preprints of the 16th IFAC World Congress: Prague, Czech Republic, July 3-8,2005, P. Horacek, ed., M. Simandl, ed., P. Zitek, ed., [Prague], IFAC, 2005, 6 pp.
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8. Vladimir Jovan, Boštjan Hauptman: An algorithm for reactive batch sequencing. EFTA 2005: 10th IEEE International Coference on Emerging Technologies and Factory Automation: proceedings: September 2005, 2005, Catania, Italy, Lucia Lo Bello, ed., Thilo Sauter, ed., Piscataway, IEEE, 2005, Zv. 2, pp. 833-840.
9. Gregor Kandare: Automatic programme synthesis. Proceedings of the 6th International PhD Workshop on Systems and Control, October 4-8, 2005, Izola, Simonov zaliv, Slovenia: young generation viewpoint, Dejan Tinta, ed., Uroš Benko, ed., Ljubljana, Institut Jožef Stefan, 2005, 6 pp.
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3. Janko Vončina: Feasibility study for computer control of buildings (Juš Kocijan)

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# INTERNATIONAL PROJECTS

1. Towards Knowledge - Based Processing Systems
   PRISM
   6. FP; MRTN-CT-2004-512233
   EC; Imperial College of Science Technology and Medicine, London, Great Britain
   Dr. Mina Žele, Dr. Gregor Kandare
2. The Control System for the Plasma Cleaning Machine
   Primož Eiselt, PlasmaBull GmbH, Lebring, Avstria
   Dr. Vladimir Jovan
3. Data-Driven Modelling for Decision-making Support and Process Monitoring
   BI-CZ/05-06/008
   Dr. Tatiana Valentine Guy, Institute for Information Theory and Automation, Department of Adaptive Control, Prague, Czech Republic
   Asst. Prof. Andrej Rakar, Asst. Prof. Đani Juričić

4. Optimal Control of Biological Wastewater Treatment Plants
   SLO-ITA 4B/2002-2005, BI-IT/02-05-022
   Prof. Stefano Marsili-Libeli, University of Florence, Department of Systems and Computers, Florence, Italy
   Dr. Nadja Hvala
5. Advanced Modelling Techniques for Distrubuted Parameter Systems with Application to Fault Diagnosis
   BI-MK/04-05-014
   Prof. Georgi Dimirovski, Faculty of Electrical Engineering, Institute of Automation & Systems Engng., Skopje, Macedonia
   Asst. Prof. Đani Juričič
6. Design of PDI Controllers: Interchange of Technology and Experience
   BI-PT-04-06-020
   Prof. José Paulo B. De Moura Oliveira, Engineering Department, University of Trás-os-Montes e Alto Douro, Vila Real, Portugal
   Asst. Prof. Damir Vrančič

# R & D GRANTS AND CONTRACTS

1. Design of fault detection and isolation systems with application to quality assessment of electrical motors
   Asst. Prof. Đani Juričić
2. Development of an intelligent diagnostic system for rotational machines
   Asst. Prof. Đani Juričić
3. Optimization of HVAC systems using dynamic models
   Prof. Stanko Strmčnik
4. Early diagnosis of lung cancer in subjects with professional asbestosis
   Asst. Prof. Đani Juričić
5. Development and optimisation of personal military equipment
   Asst. Prof. Đani Juričić
6. Industrialization of advanced control algorithms for PLC
   Prof. Stanislav Strmčnik, Dr. Samo Gerkšič

# RESEARCH PROGRAM

1. Systems and Control
   Prof. Stanko Strmčnik

# NEW CONTRACTS

1. The methodology for software standardisation
   Raci, d. o. o., Danfoss Trata, d. d.
   Dr. Gregor Dolanc
2. LITE – A programme package for PLC batch control
   Inea, d. o. o.
   Giovanni Godena, B. Sc.
3. Improving the control of complex continuous processes
   Robotina, d. o. o.
   Giovanni Godena, B. Sc.
4. Advancement of the process of HVAC control systems development
   Goap, d. o. o., Telem, d. o. o.
   Giovanni Godena, B. Sc.
5. Reusability in the software development process
   Liko Pris, d. o. o.
   Giovanni Godena, B. Sc.
6. Development of steam consumption smoothing algorithms in Cinkarna Celje
   Cinkarna, d. d.
   Dr. Nadja Hvala
7. Analysis and validation of »case study« projects
   Synatec elektronika, d. o. o.
   Dr. Vladimir Jovan
8. The integration of production information system modules
   Inea, d. o. o.
   Dr. Vladimir Jovan
9. Development of a conceptual model of an integrated production information system
   Synatec elektronika d. o. o., Metronik d. o. o., Inea d. o. o.
   Dr. Gregor Kandare
10. Upgrade of a system for product-quality assessment
    Domel, d. d.
    Dr. Janko Petrovčič
11. HVAC systems optimisation based on dynamic system models
    Goap, d. o. o.
    Prof. Stanislav Strmčnik
12. Heat transfer model for hotel rooms
    Goap, d. o. o.
    Dr. Mina Žele

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2. Dr. Pavel Ettler, COMPUREG, Plzen, Czech Republic, 6. 6. 2005
3. Prof. Wang Qing-Guo, Department of Electrical and Computer Engineering, National University of Singapore, Singapore, 1. 7. 2005
4. Dr. Andrew Crossan, Hamilton Institute, National University of Ireland, Maynooth, Co.Kildare, Ireland, 14. 10. 2005

# STAFF

**Researchers**

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7. Prof. Juš Kocijan**
8. Dr. Janko Petrovčič**
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10. Asst. Prof. Damir Vrančič**
11. Dr. Mina Žele

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13. *Asst. Prof. Andrej Rakar**, left 01.04.2005*
14. Dr. Darko Vrečko
15. Dr. Alenka Žnidaršič***

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17. Uroš Benko**, B. Sc.
18. Satja Lumbar, B. Sc.
19. Bojan Musizza, B. Sc.
20. Boštjan Pregelj, B. Sc.
21. Aljaž Stare, B. Sc.
22. Dejan Tinta, M. Sc.
23. Sebastjan Zorzut, M. Sc.

**Technical officers**

24. Giovanni Godena, B. Sc.
25. Dr. Zoran Marinšek***

**Technical and administrative staff**

26. Janez Grom
27. Maja Janežič, B. Sc.
28. Miroslav Štrubelj

** Part-time faculty member
*** Member of industrial or other organisation

# LABORATORY FOR OPEN SYSTEMS AND NETWORKS E-5

***The main activities of the laboratory are the research and development of next-generation networks, telecommunication technologies, components and integrated systems, and information society services and applications, especially those which assure the efficient and pervasive life-long learning concept.***

Head:
***Prof. Borka Jerman Blažič***

In 2005, the research group implemented a research program "Technology, services and business in next generation networks". Research was also carried out in the 5th (FP5) and 6th EU Framework Programme (FP6) projects ELENA, PROLEARN, DAIDALOS, DIADEM, iCamp, ALIPRO and BReATH, in the PHARE projects FOCUS SIAT and E-VINTER, in the MAUSE project from the COST programme, and in a few national projects. The main fields of work were technology-enhanced learning, security and privacy in information systems, advanced next-generation networks, benchmarking and road-mapping of mobile communication research programs, and monitoring and strategy modelling of broadband communications.

### Technology enhanced learning

In the FP5 project ELENA (Creating a Smart Space for Learning) we connected different educational nodes together, such as EducaNext (www.educanext.org), and participated in the building of a system for human capital development, HCD Suite (www.hcd-online.com), which is also available in Slovene. The HCD Suite enables effective searching, selection, and use of learning resources. We also defined a learner profile scheme that enables personalization of learning services and takes privacy aspects into account. Our solutions and improvements to the e-learning standards were published in an SCI journal "Computer Standards and Interfaces".

PROLERAN (Network of Excellence in Professional Learning) is an FP6 network of excellence in the field of technology-enhanced professional learning. The network brings the most important research groups in the area of professional learning and training together with key organisations and industrial partners, bridging the currently existing gap between research and education at universities and similar organisations, and with the training and continuous education that is provided within companies. In 2005, our group was involved in research on privacy and security in technology-enhanced professional learning and heterogeneous educational node connection.

The project "Fostering cross border e-business cooperative environment through the usage of advanced networked e-learning and e-business services" or, in short, FOCUS-SIAT, was part of the Interreg programme for the border regions between Slovenia and Austria. FOCUS-SIAT builds its approach through the co-ordinated cross-border network activities oriented towards offering exchange of knowledge on best-practices in e-business. With training and education (161 qualified candidates) of the different target groups in three regions, the main objective of the project was achieved, i.e., increasing the management proficiency level in small and medium-sized enterprises and local authorities through improvement of their knowledge and skills required for e-business applications. During the project we also performed usability tests of a multilingual learning resource repository in a multi-cultural environment. The first results were published in a scientific journal, while further results have been accepted for publication in the reputable journals, "Behaviour and Information Technology" and the "Journal of the American Society for Information Science and Technology". Research was also carried out to assess the Learning Management System (LMS) applicability and adequacy in different environments. We developed a multi-attribute decision-making model for the evaluation of LMSs, and published the results in a scientific journal.

The main goals of the E-VINTER project are: (1) establishment of an expert centre for evaluation, standardization, and counselling for the selection of optimal e-tools for the creation of e-learning environments, (2) development of e-skills and competences in the framework of the preparation for the national vocational training qualification, and (3) a pilot training implementation through the established innovative learning environments in the Drava, Mura, and Carinthia designated regions. The research work was aimed at investigating the latest generation of educational technologies, which have been changing information systems into the integrated learning environment of everyday life and business. On the basis of research results and international trends in this field, an occupational standard and an expert knowledge and skill standard catalogue for the 'information security expert' are being prepared. The research results have been published in a scientific journal and several conference papers.

The main goal of the MAUSE (Towards the Maturation of IT Usability Evaluation) project is to bring more science to bear on Usability Evaluation Methods (UEM) development, evaluation, and comparison, aiming for results that can be transferred to industry and educators, thus leading to increased competitiveness of European industry and benefit to the public. In 2005 we built the MAUSE Digital Library where we collect, describe, and compare different usability evaluation methods and techniques. In the framework of the INTERACT 2005 conference we organized the International COST 294 Workshop on User Interface Quality Models. In the autumn we started with preparation of a book titled "Maturing Usability: Quality in Software, Interaction and Value", which will be published in 2006 by Springer.

Project iCamp (Innovative, inclusive, interactive & intercultural learning campus) is a new IST project within the EU FP6 framework. The main goal of the project is to provide an infrastructure - the iCamp Space - for collaboration and social networking across systems, countries and disciplines. The iCamp Space, which started in autumn 2005, will build on existing interfaces and integrate shared community features. Interoperability amongst different open source learning systems and tools is the key to successful sustainability of iCamp.

**Security and privacy in information systems**

Information security and privacy are still one of the most important research fields of the laboratory. In 2005 we finished with research activities on active network security. The final results were published in an SCI journal, Computer Communications. In the focused research project 'Computer criminality in Slovenia: analyses of the situation and proposed measures' we are assessing the real situation of computer criminality in Slovenia. Besides the aforementioned research on privacy in technology enhanced learning, we are developing, within the framework of the FP6 DIADEM (Distributed Adaptive Security by Programmable Firewall) project, a comprehensive solution for the protection of broadband networks and services. The distributed firewall prototype, based on programmable network principles, has been designed and developed. The prototype enables dynamic and flexible detection, decision, and response, to various security threats.

In the area of electronic data protection our research and development was focused on long-term archive services, with an emphasis on the interaction between a user and an electronic archive. In 2005 we finalized the system architecture and defined a protocol LTAP (Long-term Archive Protocol). The protocol was published as an Internet draft (draft-ietf-ltans-ltap-00.txt) and is currently being standardized in the IETF LTANS (Long-term Archive and Notary Services) WG. The long-term archive service was implemented as part of the eKeeper system, and is currently in use by several institutions, e.g. the Slovenian Ministry of Defence.

A vision of the integrated FP6 project DAIDALOS (Designing Advanced network Interfaces for the Delivery and Administration of Location independent, Optimised personal Services) was to seamlessly integrate heterogeneous network technologies that allow network operators and service providers to offer new and profitable services, giving users access to a wide range of personalised voice, data, and multimedia services. In 2005 we finished the implementation of the models for privacy policy negotiation and identity management.

**Monitoring of telecommunications development**

In 2005, we prepared an analysis of national research projects in the field of mobile communications in new EU member states. The research was linked to the FP6 ALIPRO (Supporting the Alignment of IST Research Programmes on Mobile Communications in the New Member States) project. In another project BReATH (Broadband e-Services and Access for the Home) we started a survey of the current status of broadband access and services deployment in new EU member and associated states.

## Some outstanding publications in the past three years


1. Gabrijelčič, Dušan, Jerman-Blažič, Borka, Tasič, Jurij F. Future active Ip netwoks security architecture. Comput. commun.. [Print ed.], 2005, vol. 28, pp. 688-701.
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2. Tomaž Klobučar, DAIDALOS project meeting, FP6 of EU, 29. - 30. 8. 2005.

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1. Tanja Arh: Metodologija e-učenja za mala in srednja podjetja v podporo uveljavljanju koncepta vseživljenskega učenja. Sinergija metodologij: zbornik 24. mednarodne konference o razvoju organizacijskih znanosti, Slovenija, Portorož, 16. - 18. marec 2005: proceedings of the 24th International Conference on Organizational Science Development, Slovenia, Portorož, March 16 -18, 2005, Jindřich Kaluža, ed., Kranj, Moderna organizacija, 2005, pp. 174-181.
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2. Dušan Gabrijelčič: Safe architectures of active networks, (Prof. Borka Jerman Blažič).

### M. Sc. Theses

1. Simon Olup: Modern network solutions analysis and implementation of Content Management System (CMS) in Banka Koper, (Prof. Borka Jerman Blažič).
2. Alja Guček: E-business in Public Administration office (eUprava) and (eDohodnina) service, (Prof. Borka Jerman Blažič).
3. Marko Rožman: The evaluation of the new technologies for the expansion of efficient optical networks, (Prof. Borka Jerman Blažič).
4. Vladimir Ljevja: The evaluation of the automatically testing telecommunication equipment tools, (Prof. Borka Jerman Blažič).
5. Aleš Mazej: Choosing the technologies for Ethernet signals transfer through Telekom Slovenije's network, (Prof. Borka Jerman Blažič).
6. Suzana Verdel: The estimation of business and technological risk of mobile paying, (Prof. Borka Jerman Blažič).
7. Tanja Arh: A system overview of technologically supported education: The evaluation of standards and e-learning management modules, (Prof. Borka Jerman Blažič).
8. Darinka Ošlak: The safety in e-business in Slovenian banking, (Prof. Borka Jerman Blažič).

### B. Sc. Theses

1. Jure Razinger: The role of e-newspapers in information society (Prof. Borka Jerman Blažič).
2. Martin Anžel: The comparison and estimation of e-banking between Nova Ljubljanska Banka and Bank Austria Creditanstalt d.d (Prof. Borka Jerman Blažič).
3. Davor Pavlić: The development of banking services with e-business technologies (Prof. Borka Jerman Blažič).
4. Anton Rajk: Distant solution of conflicts in e-business (Prof. Borka Jerman Blažič).
5. Simon Demšar: Evaluation of websites' market success (Prof. Borka Jerman Blažič).

# INTERNATIONAL PROJECTS

1. Intercultural Learning Campus
   iCAMP
   6. FP; 027168
   EC; Claudia Magdalena Fabian, Zentrum für Soziale Innovation, Vienna, Austria
   Prof. Borka Jerman Blažič, Dr. Tomaž Klobučar
2. Broadband e-Services and Access for the Home
   BReATH
   6. FP; 015893
   EC; Rene Kramer, Technische Universiteit Eindhoven, Eindhoven, MB, Netherlands
   Prof. Borka Jerman Blažič
3. Supporting the ALIgnment of IST research PROgrammes on mobile communications in the new member states
   ALIPRO
   6. FP; 015811
   EC; Jan Kaczmarek, Foundation Mobile Open Society through Wireless Technology (MOST), Warsaw, Poland
   Prof. Borka Jerman Blažič

4. Network of Excellence in Professional Learning
   PROLEARN; 6. FP; 507310
   EC; Martin Wolpers, Universität Hannover, Hannover, Germany
   Prof. Borka Jerman Blažič
5. Distributed Adaptive Security by Programmable Firewall
   DIADEM FIREWALL; 6. FP; 002154
   EC; Yannick Carlinet, France Telecom SA, Paris, France
   Prof. Borka Jerman Blažič
6. Designing Advanced Interfaces for the Delivery and Administration of the Location Independent Optimised Personal Services
   DIADALOS; 6. FP; 506997
   EC; Angela Grossmann, Riccardo Pascotto, T-Systems Nova GmbH, Berlin; Bonn, Germany
   Prof. Borka Jerman Blažič
7. Creating innovative learning environment, e-skills and competences development for supporting the promotion of Informal education in Lifelong Learning
   E-VINTER; SI.71-751-03 0305 0004, 05-25-U3
   Phare 2003 Lifelong learning; EC
   Prof. Borka Jerman Blažič
8. Creating a Smart Space for Learning
   ELENA; 5. FP; IST-2001-37264
   EC; Barbara Kieslinger, BIT - Bureau for International Research and Technology Cooperation, Vienna, Austria
   Prof. Borka Jerman Blažič
9. Towards the Maturation of IT Usability Evaluation – MAUSE
   COST 294; EC
   Prof. Borka Jerman Blažič
10. Multimedia Tools for Environmental Informatics
    BI-GR/02-05-010
    Prof. Nikos Sakkas, Technological and Educational Institute of Crete, Heraklion, Greece
    Prof. Borka Jerman Blažič

# R & D GRANTS AND CONTRACTS

1. Designing Advanced Interfaces for the Delivery and Administration of Location independent Optimized personal services
   Prof. Borka Jerman Blažič
2. Quality of Service Provision in Next Generation Networks
   Prof. Borka Jerman Blažič
3. Cyber crime in Slovenia: analysis and suggestions
   Prof. Borka Jerman Blažič
4. Technologies for education and development of innovative environment
   Prof. Borka Jerman Blažič
5. Protocols and integration of services in NGN convergence systems
   Prof. Borka Jerman Blažič
6. Security and data safety in defense information communication system
   Prof. Borka Jerman Blažič

# RESEARCH PROGRAM

1. Technologies, services and business in the next generation networks
   Prof. Borka Jerman Blažič

# NEW CONTRACT

1. Participating E-VINTER project
   Ministry of Higher Education, Science and Technology
   Džonova Jerman Blažič Borka

# VISITORS FROM ABROAD

1. Prof. Václav Matyáš, Masaryk University Brno, 4. - 5. 7- 2005
2. Prof. Milan Randić, Iowa State University, ZDA, 20. - 22. 7. 2005
3. RTV Srbija, 22. 12. 2005

# STAFF

**Researcher**

**1. Prof. Borka Jerman Blažič**, Head**

**Postdoctoral associate**

2. Dr. Tomaž Klobučar**

**Postgraduates**

3. Tanja Arh, M. Sc.
4. Dr. Dušan Gabrijelčič**
5. Aleksej Jerman Blažič, M. Sc.***
6. Andrej Jerman Blažič, B. Sc.
7. Matija Pipan, B. Sc.

**Technical officers**

8. Krešimir Jadronja, B. Sc.
9. Neda Bogdanović Golić, B. Sc.,***

**Technical and administrative staff**

10. Tatjana Martun, secretary

** Part-time faculty member
*** Member of industrial or other organisation

# DEPARTMENT OF COMMUNICATION SYSTEMS E-6

***The Department of Communication Systems is concerned mainly with the research, design, and simulation, of fixed and mobile wireless communication systems, and the development of new algorithms for parallel and distributed computing and computer simulations. Other research activities include the development of software tools for testing, modelling and simulation of communication systems, provision of security services in communication networks, digital signal processing in medicine, development of distributed environments for computer supported co-operative work, teleworking, education of young researchers, and transfer of knowledge and new technologies to industry.***

Head:
***Prof. Gorazd Kandus***

Research and development work at the department can be grouped into two parts. Both groups are thematically connected and work together, particularly on applied projects.

**Telecommunication Systems**

The research group for Telecommunication systems was, in 2005, mainly concerned with the research, design and simulation of terrestrial, stratospheric and satellite mobile communication systems, broadband wireless access, and ad hoc networks. We were attempting to implement advanced and innovative concepts and technologies which would enable interworking, convergence of networks, and the mobility of terminals and networks. Particular emphasis was given to solutions providing network robustness, security, and quality of services.

In the field of radio communications we studied propagation in the radio channel. We designed and analysed new adaptive modulation and coding techniques, synchronization and equalization techniques, and techniques to assess the quality of the radio channel. We estimated the communication system complexity, the power efficiency of modulation schemes, and the capacity of the radio channel. We investigated new techniques for space-time coding and multiplexing in MIMO wireless systems. We also studied space diversity transmission techniques which increase system reliability and the probability of correctly received radio signals.

In the area of wireless access systems we were intensively involved in the study of stratospheric communications. The aim of the research was to design a telecommunication infrastructure based on high altitude platforms, capable of the provision of broadband services from the stratosphere. This concept combines some of the best characteristics of terrestrial and satellite communication systems. The main effort was focused on the system architecture and network topology design for broadband wireless access in the provision of IP-based services. We also studied network mobility issues in HAP networks and the route optimization issue in multi-level mobility architecture. In particular, the work included testing a solution to the intra-domain route optimization problem in a network mobility scenario based on HMIP route optimization, investigation of alternative locations for a home agent to reduce the overall network load, and network layer handover support.

Within the FP6 NoE (Network of Excellence) project SatNEx (Satellite Communications Network of Excellence) we studied different routing algorithms for non-geostationary satellite telecommunication networks with particular focus on signalling issues. We investigated the employment of High Altitude Platforms (HAPs) in a hybrid system consisting of HAPs and GEO satellites in order to provide an effective means for reliable multicast transmissions. In addition, we designed a radio channel model to evaluate the adaptive coded modulation algorithms with particular attention to MIMO and space-time coding techniques.

Within the FP6 STREP project CAPANINA (Communications from Aerial Platform Networks delivering Broadband Communications for All) we worked on several topics, such as system architecture design, selection of broadband communication standards, networking issues, and radio interface design. We continued the analysis of adaptive coding and modulation (ACM) combined with the platform diversity technique. We developed an empirical HAP channel model based on the digital relief model and ray tracing approach. The main research effort was focused on the investigation of network mobility issues in HAP networks and route optimization in multi-level mobility architecture.

**We participated in the FP6 project CAPANINA. The project is focused on developing advanced communications technologies for use with stratospheric platforms with the aim of providing broadband wireless access to users in remote hard-to-reach regions.**

In the year 2005 we also implemented the pilot TETRA network for the Ministry of Defence. We set up an experimental environment to test new applications in the TETRA network such as GIS, AVL, video transmission, communication via satellite, etc.

We have designed and upgraded a simulation model for the development, testing and evaluation of the performance of the next generation networks NGN using the OPNET Modeler. Using the simulation tool, it is possible to test and study the functionality, performance and basic features of the next generation network and to analyse different data transmission parameters (e. g. packet loss, delay and jitter) and protocols.

In collaboration with Iskra Transmission and Telsima we developed a simulation model and radio network development tool enabling calculation and graphical output for signal coverage at the 3.5 GHz frequency band. The tool has a user-friendly graphical interface and considers several base station parameters such as antenna height, transmitting power, antenna gain, and type of terrain. With further modifications it is possible to adapt this simulation tool for the different frequency bands used in radio communications.

**Parallel and Distributed Systems**

Computer algorithms for efficient and secure implementation on parallel and distributed computers have been investigated. Software tools for cluster computing have been tested on a 32-processor cluster computer, which runs in our department, and on a grid, recently installed in cooperation with the Faculty of Computer and Information Science, University of Ljubljana and the small enterprise company Xlab d.o.o. Computer simulations for medical applications have been investigated and applied in several practical examples. New numerical methods based on mesh-less computing have been developed. A doctoral dissertation, with important results on the accuracy and complexity of the parallel mesh-less methods implementation, was defended. We have submitted several publications from this area that could be of great interest for the wider research community.

In the field of medical research, a spatial model of a human knee with the resolution of 1 mm was created in cooperation with colleagues from the Clinical Centre Ljubljana (KC). We improved the simulation of the heat transfer in biological tissues, including heat transfer in the fluids that surround tissues. A parallel simulation program was completed using advanced numerical methods (multi-grid). Parallel programs are being developed for the simulation of knee cooling after surgery or injury. Several contributions have been published in international conferences from this area; a publication in an international journal is expected in the near future.

In cooperation with medical doctors from the Clinical Centre Ljubljana the mutual interaction among respiration, heart rate and systolic pressure has been investigated. The application software for the new measurement system Nerve, which is able to acquire, in addition to EGG, on-line signals of the respiration rate and blood pressure, has been further developed. New programs for the analysis of the baroreceptor sensitivity (BRS) have been implemented. We published contributions to specialized international conferences, and we also expect a new subject for an interdisciplinary doctoral dissertation. Our colleague from KC recently defended her doctoral dissertation entitled: Variability of ECG after heart transplantation. The main results have been published in an ISI journal.

In the area of computer and information systems security we focused on methodologies for quantitative and qualitative modelling to support security management. We developed a generic model focused on the human factor. We also developed a family of lightweight protocols for the efficient provision of security services with low processing power devices. This family of protocols is suitable for embedded computing (patent pending). Further, we published three scientific papers in international journals and proceedings.

In the field of discrete systems modelling and development, we adapted our algorithm for automated synthesis of distributed servers based on specifications written in LOTOS/T+ to the standard language E-LOTOS. It turned out that the synthesis would be much easier to conduct if the processes were modelled with event structures. As no event-structure semantics existed for E-LOTOS, we had to propose one, but first, we had to develop a new kind of event structures with enhanced expressive power. We also investigated automated finite-state-machine-based synthesis of test sequences, questioning the usual practice of translating the optimization problem to the Rural Postman Problem. We found out that it would be much better to translate to the Asymmetric Generalized Travelling Salesman Problem, to facilitate the integrated handling of various optimization concerns. Our research results from the area of formal methods for discrete systems have been published in a paper in an international journal.

## Some outstanding publications in the year 2005


1. T. Javornik, M. Mohorčič, A. Švigelj, I. Ozimek, G. Kandus, Adaptive Coding and Modulation for Mobile Wireless Access Via High Altitude Platforms, Wireless Personal Communications, vol. 32, issue 3-4, 2005, 301-317
2. T. Javornik, S. Plevel, G. Kandus, A Recursive Link Adaptation Algorithm for MIMO System, AEÜ, International Journal of Electronics and Communications, vol. 59, 2005, 52-54
3. D. Grace, M. H. Capstick, M. Mohorčič, J. Horwath, M. Bobbio Pallavicini, M. Fitch, Integrating Users into the Wider Broadband Network via High Altitude Platforms, IEEE Wireless Communications, vol.12, no.5, 2005, 98-105
4. M. Šterk, R. Trobec, Biomedical simulation of heat transfer in a human heart. J. chem. inf. comput. sci., vol. 45(6), 2005, 1558-1563
5. M. Kapus-Kolar, Towards weak sequencing for E-LOTOS, Computer Standards & Interfaces, vol. 28(1), 2005, 59-73


## Organization of conferences, congresses and meetings

1. International Workshop on Parallel Numerics 2005, Portorož, 20.04.-23.04. 2005

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## ORIGINAL ARTICLES


1. David Grace, M. H. Capstick, Mihael Mohorčič, Joachim Horwath, Marco Bobbio Pallavicini, Michael Fitch: Integrating users into wider broadband network via high altitude platforms. IEEE wirel. commun., Vol. 12, pp. 98-104, 2005.
2. Tomaž Javornik, Mihael Mohorčič, Aleš Švigelj, Igor Ozimek, Gorazd Kandus: Adaptive coding and modulation for mobile wireless access via high altitude platforms. Wirel. pers. commun., Vol. 32, pp. 301-317, 2005.
3. Tomaž Javornik, Srečo Plevel, Gorazd Kandus: A recursive link adaptation algorithm for MIMO systems. AEÜ, Int. j. electron. commun. (Print), Vol. 59, pp. 52-54, 2005.
4. Monika Kapus-Kolar: Towards weak sequencing for E-LOTOS. Comput. stand. interfaces, Vol. 28, pp. 59-73, 2005.
5. Igor Ozimek, Andrej Hrovat: Concurrent POCSAG and TETRA paging. WSEAS transactions on communications, Vol. 5, pp. 31-36, 2005.
6. Marjan Šterk, Roman Trobec: Biomedical simulation of heat transfer in a human heart. J. chem. inf. comput. sci., Vol. 45, pp. 1558-1563, 2005.
7. Aleš Švigelj, Mihael Mohorčič, Gorazd Kandus: Traffic class dependent routing in ISL networks with adaptive forwarding based on local link load information. Space commun., Vol. 19, pp. 158-170, 2004.
8. Denis Trček: MAC based lightweight protocols for strong authentication and key exchange. J. inf. sci. eng., Vol. 21, pp. 1-13, 2005.


## REVIEW ARTICLES AND CHAPTERS IN BOOKS


1. Igor Rozman, Roman Trobec, Marjan Šterk: Tuning communication in gigabit ethernet cluster. Parallel numerics '05: theory and applications, Marian Vajteršic, ed., Roman Trobec, ed., Peter Zinterhof, ed., Andreas Uhl, ed., Ljubljana, Jožef Stefan Institute, Salzburg, University, 2005, pp. 207-216.
2. Marjan Šterk, Borut Robič, Roman Trobec: Mesh free method applied to diffusion equation. Parallel numerics '05: theory and applications, Marian Vajteršic, ed., Roman Trobec, ed., Peter Zinterhof, ed., Andreas Uhl, ed., Ljubljana, Jožef Stefan Institute, Salzburg, University, 2005, pp. 57-66.
3. Denis Trček: E-business systems security for intelligent enterprise. Encyclopedia of information science and technology, Mehdi Khosrowpour, ed., Hershey [etc.], Idea Group Reference, cop. 2005, Zv. I-V, pp. 930-933.
4. Roman Trobec: Faster computer and algorithms in scientific computing. Scientific computing in Salzburg: festschrift on the occasion of Peter Zinterhofs 60th birthday: [die Veranstaltung "invited talks of the Sceintific computing minisymposium" fand am 15. Oktober 2004 in Salzburg statt](books@ocg.at, band 189), Helmut Efinger, ed., Andreas Uhl, ed., Wien, Oesterreichische Computer Gesellschaft, 2005, pp. 37-44.
5. Rainer Trummer, Peter Zinterhof, Roman Trobec: A high-performance data-dependent hardware divider. Parallel numerics '05: theory and applications, Marian Vajteršic, ed., Roman Trobec, ed., Peter Zinterhof, ed., Andreas Uhl, ed., Ljubljana, Jožef Stefan Institute, Salzburg, University, 2005, pp. 193-206.


## PUBLISHED CONFERENCE PAPERS

### Invited Paper


1. David Grace, Mihael Mohorčič, M. Oodo, J. Horwath, M. H. Capstick, M. Bobbio Pallavacini, M. Lalovic: An overview of the European CAPANINA project - broadband for all from high altitude platforms. Proceedings, SPSW2005 The Fifth Stratospheric Platform Systems Workshop, 23-24 Februar, 2005, Tokyo, Japan, [S.l., s.n.], 2005, pp. 106-112.


### Regular Papers


1. Matteo Berioli, Giovanni Giambene, Ivano Alocci, Mihael Mohorčič, Erina Ferro, Fernando Perez Fontan, Pavlidou Fotini-Niovi: Hybrid HAP-satellite architecture for reliable multicast transmissions. Joint conference 2005, 23rd AIAA International Communications Satellite Systems Conference (ICSSC-2005 & 11th Ka and Broadband Communications Conference, 25-28 September 2005, Rome, Italy, Genoa, Istituto Internatinale dlle Comunicazione, 2005, 12 pp.
2. David Grace, Mihael Mohorčič, M. Oodo, M. H. Capstick, M. Bobbio Pallavacini, M. Lalovic: CAPANINA - communications from aerial platform networks delivering broadband information for all. [Proceedings], 14th IST Mobile & Wireless Communications Summit, Dresden, Germany, 19-23 June 2005, [S.l., s.n.], 2005, 5 pp.
3. Igor Jelovčan, Tomaž Javornik, Gorazd Kandus: Performance evaluation of BWA systems with suboptimal turbo decoding. Eurocon 2005: proceedings, The International Conference on "Computer as a Tool", Belgrade, Serbia and Montenegro, November 21-24, 2005, Ljiljana Milić, ed., Belgrade, University of Belgrade, School of Electrical Engineering, Institute of Electrical and Electronics Engineers, cop. 2005, pp. 449-452.
4. Gorazd Kandus, Srečo Plevel, Tomaž Javornik: The performance of multi-mode spatial MIMO system with imperfect CSI. Proceedings of the WSEAS International Conferences, Tenerife, Canary Islands, December 16-18, 2005, Athens, World Scientific and Engineering Academy and Society (WSEAS), International Association of Mechanical Engineers (IASME), 2005, pp. 478-481.
5. Gorazd Kandus, Aleš Švigelj, Mihael Mohorčič: Telecommunication network over high altitude platforms. Proceedings of papers. Vol. 2, TELSIKS 2005, 7th International Conference on Telecommunications in Modern Satellite, Cable and Broadcasting Services, Serbia and Montenegro, Niš, 28-30 September, Bratislav D. Milovanović, ed., Piscataway, IEEE, 2005, pp. 344-347.
6. E. Leitgeb, S. Sheikh Muhammad, Ch. Chlestil, M. Gebhrt, Gorazd Kandus, Tomaž Javornik: Importance of reliable optical wireless links in the evolving broadband network. Proceedings 2005, WMSCI 2005, The 9th World Multi-Conference on Systemics, Cybernetics and Informatics, July 10-13, 2005, Orlando, Florida, USA, [S.l.], International Institute of Informatics and Systemics, 2005, pp. 69-65.
7. E. Leitgeb, S. Sheikh Muhammad, M. Gebhrt, Ch. Chlestil, U. Birnbacher, O. Koudelka, P. Schrotter, A. Merdonig, Gorazd Kandus: Hibrid wireless networks combining WLAN, FSO and sattelite technology for disaster recovery. [Proceedings], 14th IST Mobile & Wireless Communications Summit, Dresden, Germany, 19-23 June 2005, [S.l., s.n.], 2005, 5 pp.
8. S. Sheikh Muhammad, T. Kamalakis, E. Leitgeb, O. Koudelka, Gorazd Kandus, Tomaž Javornik: Terrestrial free space optical links for high bandwidth connectivity. Proceedings of the INMIC 2005, 9th International Multi-topic Conference: December 24-26,2005, [Islamad] Pakistan, Karachi, National University of Computer and Emerging Sciences, 2005, 5 pp.
9. Roman Novak, Mihael Mohorčič, Aleš Švigelj, Gorazd Kandus: IP mobility architecture for high altitude platform networks. International Workshop on High Altitude Platform Systems - WHAPS '05: in conjunction with the Mediterranean Microwaves Symposium 2005,(MMS 2005): Athens, September 5,2005, 2005, 5 pp.
10. Igor Ozimek, Andrej Hrovat: Paging forwarding from POCASG to TETRA. Proceedings of the WSEAS conferences: 5th WSEAS Int. Conf. on Applied Informatics and Communications (AIC'05), 5th WSEAS Int. Conf. on Signal Processing, Computational Geometry & Artificial Vision (ISCGAV'05), 5th WSEAS/IASME Int. Conf. on Systems Theory and Scientific Computation (ISTASC'05), Malta, September 15-17,2005, [S. l.], WSEAS, 2005, pp. 39-41.
11. Srečo Plevel, Tomaž Javornik, Mihael Mohorčič, Gorazd Kandus: Empirical propagation channel model for high altitude platform communication systems. Joint conference 2005, 23rd AIAA International Communications Satellite Systems Conference (ICSSC-2005 & 11th Ka and Broadband Communications Conference, 25-28 September 2005, Rome, Italy, Genoa, Istituto Internatinale dlle Comunicazione, 2005, 8 pp.
12. Igor Rozman, Roman Trobec, Marjan Šterk: Hitrost komunikacije v LAM/MPI in MPICH okoljih. Zbornik štirinajste mednarodne Elektrotehniške in računalniške konference ERK 2005, 26. - 28. september 2005, Portorož, Slovenija(Zbornik... Elektrotehniške in računalniške konference ERK...), Baldomir Zajc, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2005, Zv. B, pp. 3-6.
13. Denis Trček: Holistic systems dynamics based framework for human resources management in information systems security. Proceedings of The WOSC 13th International Congress of Cybernetics and Systems, 6-10 July, 2005, Maribor, Slovenia, Nicolae Bulz, ed., Marcel Stoica, ed., Matjaž Mulej, ed., Adriana Grigorescu, ed., Robert G. Dyck, ed., Borut Likar, ed., Denis Trček, ed., Liu Si-feng, ed., Tat'iana A. Medvedeva, ed., Vojko Potočan, ed., Robert Vallée, ed., Elohim Jiménez-López, ed., Sonja Sibila Lebe, ed., Markus Schwaninger, ed., Maribor, Faculty of Economics and Business, 2005, Zv. 4, pp. 47-56.
14. Roman Trobec, Marjan Šterk, Said AlMawed, Matjaž Veselko: Computer simulation of human knee cooling. ICNAAM: international conference on Numerical Analysis and Applied Mathematics 2005: official conference of the European Society of Computational methods in Sciences and Engineering (ESCMSE), 16-20 September 2005, Rhodes, Greece, Theodore Simos, ed., G. Psihoyios, ed., Ch. Tsitouras, ed., Weinheim, Wiley-VCH, 2005, pp. 556-560.
15. Roman Trobec, Marjan Šterk, Said AlMawed, Matjaž Veselko: Computer simulation of topical knee cooling. Proceedings of the IASTED International Conference on Parallel and Distributed Computing and Networks: as part of the 23rd IASTED International Multi-Conference on Applied Informatics: February 15-17, 2005, Innsbruck, Austria, Thomas Fabringer, ed., Mohamed H. Hamza, ed., Anaheim, Calgary, Zurich, Acta Press, 2005, pp. 573-577.
16. Boris Turk, Aleš Štimec, Marjan Šterk, Igor Rozman, Gregor Pipan, Roman Trobec: GRIDdy - a globus toolkit framework. Proceedings, Cracow '04 Grid Workshop, December 13-15, 2004, Cracow, Poland, Marian Bubak, ed., Michał Turała, ed., Kazimierz Wiatr, ed., Kraków, Academic Computer Centre, 2005, pp. 248-255.
17. Andrej Vilhar, Roman Novak: Home agent placement optimization for HAP-based network mobility. International Workshop on Satellite and Space Communications 2005, IWSSC, as part of ISWCS'05, 2nd Internatinal Symposium on Wireless Communicatin Systems 2005: September 8-9, 2005, Siena, Italy, Siena, IEEE Communicatins Society, 2005, 6 pp.


## TEXTBOOKS AND LECTURE NOTES


1. Denis Trček: Elektronsko poslovanje: Ljubljana, Fakulteta za računalništvo in informatiko, 2005.

2. Denis Trček: Varnostni standardi za ravnanje informacijskih sistemov: Ljubljana, Institut Jožef Stefan, 2005.
3, Denis Trček, Jernej Vičič: Računalniška varnost: (Zbirka Študijska gradiva, zv. 18), 1. natis, Koper, UP, Pedagoška fakulteta, 2005.

## THESES

### Ph. D. Theses

1. Marjan Šterk: "Mesh Free Methods on Parallel Computers" (Prof. Borut Robič, Asst. Prof. Roman Trobec)
2. Tomaž Aljaž: »The Concept of Multi-Service Mediator in Telecommunication Next Generation Networks« (Prof. Gorazd Kandus)

# INTERNATIONAL PROJECTS

1. Partner Search Support for participants in IST Priority by European network of NCP for IST under the 6th Framework Program
   Idealist 34; 6. FP; 511355
   EC; dr. Roland Pleger, Deutsches Zentrum für Luft und Raumfahrt E. V. (DLR), Köln, Germany
   Dr. Mihael Mohorčič
2. Satellite Communications Network of Excellence
   SATNEX; 6. FP; 507052
   EC; Prof. Erich Lutz, Deutsches Zentrum für Luft und Raumfahrt E. V. (DLR), Köln, Germany
   Prof. Gorazd Kandus
3. Communications from Aerial Platform Networks Delivering Broadband Communications for All; CAPANINA; 6. FP; 506745
   EC; Graham Long, University of York, York Electronics Centre, York, Great Britain
   Dr. Mihael Mohorčič
4. GISAS - Geographical Information Systems (GIS) Applications for Schools
   SOCRATES/MINERVA; 110803-CP-1-2003-1-FI-MINERVA-M
   EC; Prof. Petri Pelikka, Dr. Tino Johannsen, University of Helsinki, Department of Geography, Helsinki, Finland
   Prof. Jože Rugelj
5. Packet-oriented Service Delivery Via Satellite
   COST 272
   EC; Prof. Gerard Maral, Ecole Nationale Supérieure des Telecommunications - ENST, Toulouse, France
   Dr. Mihael Mohorčič
6. Towards Mobile Broadband Multimedia Networks
   COST 273
   EC; Prof. Luis Correia, Instituto Superior Técnico, Lizbona, Portugal
   Dr. Tomaž Javornik
7. Analysis and Design of Advanced Multiservice Networks Supporting Mobility, Multimedia and Internetworking
   COST 279; EC; Prof. dr. José Brazio, Istituto Superior Técnico, Lizbona, Portugal
   Dr. Aleš Švigelj
8. Quality of Service in Future Wireless Systems
   COST 290; EC; Prof. Yevgeni Koucheryavy, Tampere University of Technology, Tampere, Finland
   Prof. Gorazd Kandus
9. High Altitude Platforms for Communications and other Services
   COST 297; HAPCOS; EC; Prof. Tim C. Tozer, University of York, York, Great Britain
   Dr. Aleš Švigelj
10. Teledoctorate Project
    UNESCO-ROSTE Grant
    Silvano Pupolin, Universitŕ di Padova, Dipartimento di Ingegneria dell'Informazione, Padova, Italy
    Dr. Paola Magri, Consorzio Nazionale Interuniversitario per le Telecomunicazioni (CNIT'), Parma, Italy
    Prof. Gorazd Kandus
11. Quality of Service in Advanced Wireless Networks
    BI-HR/04-05-037
    Prof. Nikola Rožić, Fakultet elektrotehnike, strojarstva i brodogradnje (FESB), Split, Croatia
    Prof. Gorazd Kandus
12. Setting-up of an Inter-Institutional Test GRID Application
    BI-HR/05-06-030; Prof. Karolj Skala, Institut "Ruđer Bošković", Zagreb, Croatia
    Asst. Prof. Roman Trobec

# R & D GRANTS AND CONTRACTS

1. Broadband wireless access networks
   Prof. Gorazd Kandus
2. Computing services on GRID infrastructure
   Asst. Prof. Roman Trobec
3. GRID technology as a standard communication - computing infrastructure
   Asst. Prof. Igor Ozimek
4. Security enhanced information systems design methodology
   Prof. Denis Trček
5. Professional system of mobile communications for MORS
   Prof. Gorazd Kandus
6. Protocols and service integration in converged NGN systems
   Prof. Gorazd Kandus
7. Wireless communication platforms
   Asst. Prof. Igor Ozimek

# RESEARCH PROGRAMS

1. Telecommunication systems
   Prof. Gorazd Kandus
2. Parallel and distributed systems
   Asst. Prof. Roman Trobec

# NEW CONTRACT

1. Broadband wireless access networks
   Telsima d.o.o
   Prof. Gorazd Kandus

# VISITORS FROM ABROAD

1. Sajid Sheikh Muhammad, Graz University Of Technology, Graz, Austria, 09.–10.06.2005
2. Dr. Eich Leitgeb, Graz University Of Technology, Graz, Austria, 09.–10.06.2005
3. Dr. Aleksandar Nešić, University of Belgrade's School Of Electrical Engineering, Belgrade, Serbia and Montenegro, 12. 7. 2005
4. Prof. dr. Jan Sykora, Czech Technical University in Prague, Prague, Czech Republic, 02.–07. 07. 2005
5. Sajid Sheikh Muhammad, Graz University Of Technology, Graz, Austria, 14.–28. 09. 2005

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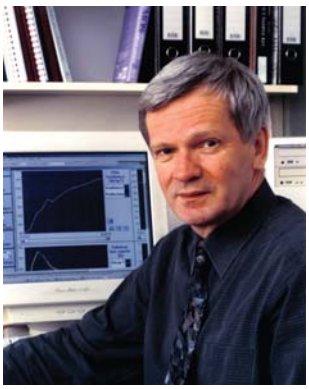
23. Tomaž Krištofelc
24. Bojan Močnik

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

# DEPARTMENT OF COMPUTER SYSTEMS E-7

***The department is concerned primarily with the design automation of computing structures and systems. Within this broad area, we are concentrating particularly on the metaheuristic approach to engineering design and logistics problems as well as system design and testing. As an integral part of our research activity, members of the department have close contacts and collaboration with scientists world-wide, through academic links and industrial contacts, thus enabling us to keep at the forefront of this rapidly developing field***



Head:
***Prof. Franc Novak***

Bio-inspired algorithms such as evolutionary optimization, neural networks, ant-colony optimization, simulated annealing, etc., are becoming increasingly important and popular for solving hard combinatorial and numerical opzimization problems in various domains of theoretical interest and practical applications. We have successfully applied evolutionary algorithms in design optimization.

Recently we have focused on stigmergic optimization algorithms. Stigmergy is a method of communication in decentralized systems in which individual parts of the system communicate with one another by modifying their local environment. It was first observed in nature as a class of mechanisms that mediate animal-animal interactions and is the basis of its collective problem solving. The term stigmergy (from the Greek stigma = sting, and ergon = to work) was originally defined by the French entomologist Pierre-Paul Grassé in response to his observations of species of termites. Stigmergy provides a new paradigm for developing decentralized, complex applications such as autonomous and collective robotics, communication in computer networks, multi-agent systems, combinatorial and numerical optimization algorithms. Using stigmergy algorithms we have achieved promising results in graph partitioning, optimization of the universal motor's geometry, and steel casting process optimization.

We have implemented a public-domain server application for modern dietary menu planning based on evolutionary optimization methods. The problem of finding a nutritionally adequate menu at least cost and highest quality is a hard optimization problem. We have introduced a combination of linear programming and a multiobjective and multiconstraint genetic algorithm for solving the menu planning problem in a multi-level way. The application is coded by the PHP scripting language, while data is managed by the MySQL relational database management system. We use the Apache HTTP server, which is currently installed on a computer at JSI. After the testing phase the application and the data will be transferred to the server supported by the Ministry of Health. The application is also of public importance because it gives an insight into nutritional data collected in Slovene laboratories in recent years simply by using the Internet.


*Figure1: Hydra multiprocessor system*

Within the FP6 project ARFLEX, we investigated the possibility of using vision sensors for robot control. The objective is to radically upgrade a class of products – industrial robots – where these technologies have not yet found full applications. The project aim is to increase flexibility and adaptability, reduce cost, and increase the field of applications on the job floor. Highly-precise mechanical parts should be substituted by low-cost modular units and sophisticated control algorithms which will use sensor data, communication networks, and real-time data processing. The system is based on a new generation of high performing embedded systems for industrial robots.

Our task within the project is to develop, test, and integrate a vision-based embedded system for closed-loop robot control which will enable 3D trajectory tracking with high precision.

In the area of embedded system design we have implemented the AES algorithm for data encryption of an external data storage unit in a dependable application. The algorithm was implemented in FPGA using the development board Celoxica RC1000 and the development suite Celoxica DK1. The purpose of this prototype version was to test the correctness of the implemented algorithm and to gain experience in optimisation of the algorithm structure for the prospective implementation embedded in the target application. In collaboration with FERI, University of Maribor, we implemented in hardware a technique for progressive lossless compression of volumetric data suitable for applications in CT or MRI scanners.

We continued our research in the field of electronic testing. We explored the conditions for the oscillation based testing of switched-capacitor biquad filter stages. Relations between parameters describing the filter circuit in the continuous time domain and the coefficients of the discrete time transfer function were studied and used to determine the necessary conditions for establishing sustained oscillations in the tested circuit. A reconfiguration


*Figure 2: a.) Server aplication for dietary menu planning using evolutionary computation, b.) Starting web page of the application*

scheme based on the transformation of the biquad filter stage to a quadratic oscillator was derived and evaluated in Spice simulations. In collaboration with the Electronic Ceramics Department we developed an approach to fault diagnosis of a piezoresistive ceramic pressure sensor based on a finite-element model. We also addressed the security problem of systems incorporating the IEEE Std. 1149.1 infrastructure. We have developed a security scheme based on a locking mechanism that prevents unauthorized access to users via a standard test access port.

## Some outstanding publications in the past three years

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## Organization of conferences, congresses and meetings

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2. 3rd workshop "Bioinspired algorithms", Portorož, Slovenia, 27. 09. 2005
3. 4th workshop "Bioinspired algorithms", Maribor, Slovenia, 15. 12. 2005

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4. Gregor Papa, Barbara Koroušić-Seljak: An artificial intelligence approach to the efficiency improvement of a universal motor. Eng. appl. artif. intell., Vol. 18, pp. 47-55, 2005.


## PUBLISHED CONFERENCE PAPERS

### Regular Papers


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3. Peter Korošec, Jurij Šilc: The multilevel ant stigmergy algorithm: an industrial case study. JCIS 2005: proceedings of the 8th Joint Conference on Information Sciences, July, 21-25,2005, Salt Lake City, Utah, USA, Salt Lake City, JCIS, 2005, pp. 475-478.
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1. Franc Novak: Design for testability: (script ): Ljubljana, Jožef Stefan Institute, 2005.
2. Franc Novak: High level synthesis: (lecture slides): Ljubljana, Jožef Stefan Institute, 2005.
3. Franc Novak: Reconfigurable computing: (lecture slides): Ljubljana, Jožef Stefan Institute, 2005.
4. Franc Novak: Sequential system diagnosis: (script): Ljubljana, Jožef Stefan Institute, 2005.

## PATENT APPLICATION

1. Franc Novak, Anton Biasizzo
   Test bus locking mechanism
   Patent application no. P-200500011

# INTERNATIONAL PROJECTS

1. Adaptive Robots for Flexible Manufacturing Systems
   ARFLEX; 6. FP; NMP2-CT-2005-016680
   EC; Dr. Gabriella Caporaletti, EICAS Automazione S.p.A., Torino, Italy
   Dr. Drago Torkar
2. EIE-Surveyor
   SOKRATES; 225997-CP-1-2005-1-FR-ERASMUS-TNPP
   EC; Prof. Jean-Marc Thiriet, Université Joseph Fourier Grenoble, Institut Universitaire de Technologie 1 de Grenoble, Département Réseaux et Télécommunications, Saint Martin d'Hères Cedex, France
   Prof. Franc Novak
3. Methods for mixed-signal test of Systems-on-Chips
   PROTEUS
   Prof. Florence Azais, Universite Montpellier II-LIRM, LIRMM, Montpellier, France
   Prof. Franc Novak

# R & D GRANTS AND CONTRACTS

1. Secure data storage unit based on new ferroelectric semiconductor memory devices
   Dr. Anton Biasizzo
2. 2D in 3D digital map system for land, aerial and sea orientation
   Dr. Drago Torkar

# RESEARCH PROGRAM

1. Computing structures and systems
   Prof. Franc Novak

# VISITOR FROM ABROAD

1. Jean-Pierre Banatre, Michel Loyer, INRIA, France, 24. 5. 2005

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4. Asst. Prof. Jurij Šilc**

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6. Dr. Gregor Papa
7. Dr. Drago Torkar
8. Dr. Alenka Žužek***

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*** Member of industrial or other organisation

# DEPARTMENT OF KNOWLEDGE TECHNOLOGIES E-8

***The Department of Knowledge Technologies performs research in advanced information technologies, aimed at acquiring, storing, and managing knowledge, which is used in the development of knowledge-based society applications. Established areas of knowledge technologies include intelligent data analysis (machine learning, data mining, and knowledge discovery in databases), text and web mining, language technologies and computational linguistics, decision support and knowledge management. Recent research areas of the department include the semantic web, virtual organizations, new media and e-science. Besides developing knowledge technologies, we also develop their applications in environmental sciences and ecology, medicine and health care, biomedicine and genetics, economics and marketing.***

Head:
***Prof. Nada Lavrač***

We developed numerous methods for **intelligent data analysis**, including methods for subgroup discovery and analysis of structured and multi-relational data, with applications to medicine, health care and bioinformatics. We contributed two chapters to the reference encyclopaedia of data mining and knowledge discovery, presenting an overview of data mining methods for (multi)relational data and methods for data analysis in medicine. We also developed methods for inductive database querying, i.e., data mining with restrictions whose aim is to extract patterns or models from the data, satisfying the constraints provided by the user. Methods were also developed for learning predictive classification trees, with size and accuracy constraints, and for learning trees for hierarchical classification into several classes. These methods were used for analysing microarray data and for predicting gene functions (functional genomics). This work was performed as part of an FP6 STREP project IQ which is coordinated by the Department of Knowledge Technologies. Methods for intelligent data analysis were also applied to a range of problems in medicine, bioinformatics and environmental sciences, especially in the areas of earthquake prediction, and in modelling the effect of exposure to mercury and the effects of genetically modified crops on the environment. Data about the concentration of radon in thermal waters were used to learn predictive models, relating anomalies in radon concentrations to earthquakes. Data about mercury exposure of miners and their health status were used to search for regularities that would connect the two. The work within the FP5 project ECOGEN and the FP6 project SIGMEA used data analysis to model the effects of genetically modified crops on the environment (e.g., on biological communities in the soil) for the automated modelling of the flow of genes between genetically modified and conventional crops, depending on meteorological and spatial factors, as well as on the farming methods used.

**The Department of Knowledge Technologies cooperated as a partner in 8 European projects and coordinated one European project (project IQ).**

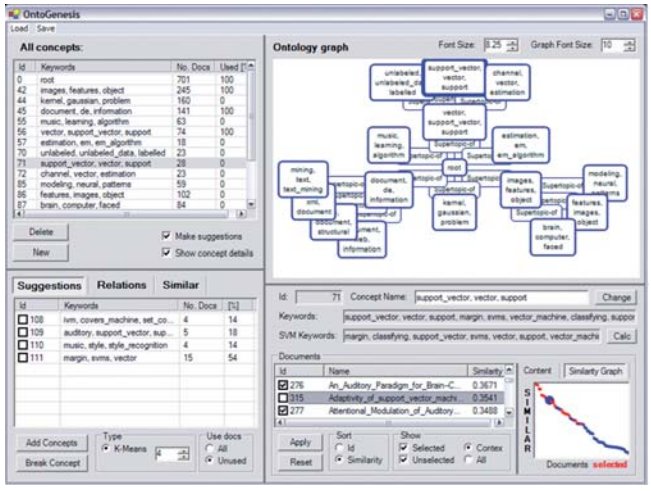


*Figure 1: OntoGen is a system for semi-automatic ontology construction. The system supports the user during the ontology construction process with integrated text mining techniques for concept discovery, ontology visualization, automatic assignment of documents to concepts and outlier detection.*

In the areas of **text and web mining** and the **semantic web** we have developed methods and prototype systems for visualizing text documents, evaluating ontologies, building ontologies from text, user profiling, and building ontologies of competencies for virtual networked organizations. We also extended ontology building to learning from sequential data (stream mining and stream ontologies) and provided support for different views of the same data (simultaneous ontologies). The methods developed were tested in several applications within the FP6 IP project SEKT. In cooperation with the German firm OntoPrise, we have integrated our ontology building system into OntoStudio, their commercial product for ontology building. We have also developed methods for processing the Slovene language for text analysis within the semantic web search engine

**We developed a new system for the automatic lemmatization of texts, a procedure for learning language-independent representations of documents, and a procedure for automatic abstraction based on a new method for building semantic graphs from text.**

**Using a system for archiving the Slovene segment of the web, we developed a collection of digitized and electronic Slovene publications that contributes to the preservation of the Slovene cultural heritage.**

(the FP6 project ALVIS). Various methods of knowledge discovery in data, especially methods of text analysis, were extended and integrated in the knowledge management and semantic web framework. We described ontology learning as a machine learning problem in which concepts, relations, or functions for assigning examples to existing ontologies are learned from data. We developed a system for processing unmarked data with methods of active and semi-supervised learning. Language technologies, developed by using machine learning methods, include a system for automatic lemmatization, a procedure for learning language-independent representations of documents and a procedure for automatic abstraction based on a new method of building the semantic graph of a text. Using a system for archiving the Slovene web, we also developed a collection of digitized and electronic Slovene publications that contribute to the preservation of the Slovene cultural heritage.

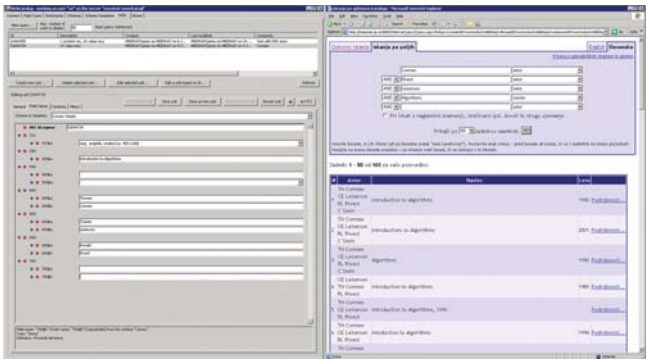

*Figure 2: WebCatalog is used to add bibliographic data to a web archive and a database of electronic publications (the left part of the image), as well as to search the catalogue and access the archived documents (the right part of the image).*

In the area of **language technologies** we further developed computational methods for processing Slovene and other languages for searching on the web, for building (multilingual) dictionaries and for supporting the translation, teaching, and scientific description of Slovene. The main achievements in the area of language resources were the development of a semantic lexicon of Slovene, based on WordNet, a prototype syntactically-marked corpus of Slovene, the development of a large English-Slovene parallel corpus of legal documents of the EU, providing assistance in developing a large corpus of military terminology, and adding extensions to a Japanese-Slovene dictionary for students. In cooperation with the research centre of the Slovene Academy of Arts and Sciences, we set up a web edition of the letters of Baron Žiga Zois, and completed most of the work on the digital edition of the Freising Manuscripts (Brižinski spomeniki), the oldest text in the Slovene language. This edition, the most sophisticated so far, contains translations and accompanying texts, digital facsimiles, all (15) scientific transcriptions and translations, a dictionary, bibliography, name index, and audio recordings of readings of the text. All these aspects of the text are inter-linked, enabling for example, the parallel presentation of many transcriptions, or transcriptions and facsimiles. In addition to their free availability on the internet in rich HTML form, an important aspect of our scientific electronic editions is that their canonical form is provided in XML, according to international standards for encoding documents for scientific purposes. This makes these editions maximally useful, and prevents them from becoming technologically obsolete.

**We developed a methodology and provided analyses with which the Slovenian Ministry of Health can monitor and further develop the health care network. In terms of criteria and data, this is the most elaborate and modern analysis in Slovenia to date.**

In the area of **decision support**, our long-term goal is to develop methods and techniques of multi-attribute modelling, implement them in object-oriented software, and integrate them with systems for data mining. We continued to develop methods for revising probabilistic multi-parametric models. On the basis of this extended methodology, we implemented the system proDEX as a tool for qualitative multi-parametric modelling and integrated it as a prototype into the Orange data analysis system. The following applications and transfers into practice were especially successful: determining the ecological and economic effects of genetically modified crops (European projects ECOGEN and SIGMEA), designing the Slovene health care network (project MediNet for the Slovenian Ministry of Health) and monitoring and evaluating portals of life-situations (in cooperation with the Faculty of Administration of the University of Ljubljana). The methods developed were used in systems for monitoring and managing traffic (DARS, the Slovene highway authority), for selecting the design of Slovene coins (Bank of Slovenia) and for evaluating the quality of education programs (project QiS).

In designing the health care network of the Republic of Slovenia, we analysed the factors involved in setting up a network of physicians and other health care workers at the primary and secondary level. The goal was to develop a methodology and provide analyses to enable the Ministry of Health to monitor and further develop the Slovene health care network. We analysed databases containing data about the health care of the Slovene population, using various data mining methods, and upgraded them with methods for decision support, visualization, and geographic information systems. We proposed parameters and indicators for developing the health care network, some of which are new in Slovenia (e.g., assessing the accessibility of health care services by considering properties of the road system), and

**Decision support methods were used in systems for traffic monitoring and management (DARS, the Slovene highway authority), for selecting the design of Slovene coins (Bank of Slovenia) and for evaluating the quality of education programs (project QiS).**

some of which are new globally (e.g., taking into account migrations of the population). We developed a methodology of coverage maps for optimizing the health care network and provided analyses, for three selected regions, of health care accessibility and the frequency of actual and predicted patient visits. The results of these analyses are available in a prototype system that supports real-time querying and provides numerous variants for reporting and visualization. In terms of the number of criteria and the amount of data covered, this is the most elaborate and modern analysis of the Slovenian health system developed to date.

## Some outstanding publications in the past three years

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5. Grobelnik, Marko, Mladenić, Dunja. Automated knowledge discovery in advanced knowledge management. Journal of Knowledge Management, vol. 9, pp. 132-149, 2005

## Organization of conferences, congresses and meetings

1. Summer school 'Advance Course on knowledge discovery' ACAI, Ljubljana, 27.6.-5.7.2005
2. Summer school 'First SEKT Summers School on Semantic Web', Ljubljana, 6.-8.7.2005
3. PASCAL Workshop on Complex object visualization, Koper, 16.-19-11.2005
4. Information Society – subconferences Data Mining and Data Warehouses (SiKDD) and Intelligent Systems, Ljubljana, 10.-17.10.2005

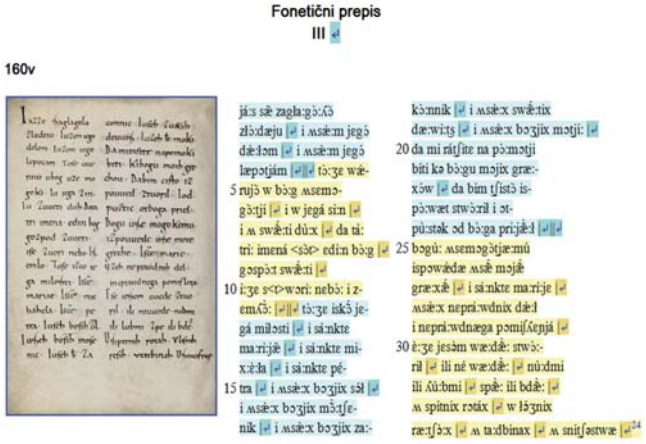


*Figure 3: e-Edition of the Freising Manuscripts (Brižinski spomeniki): Sample phonetic transcription, with links to speech files.*

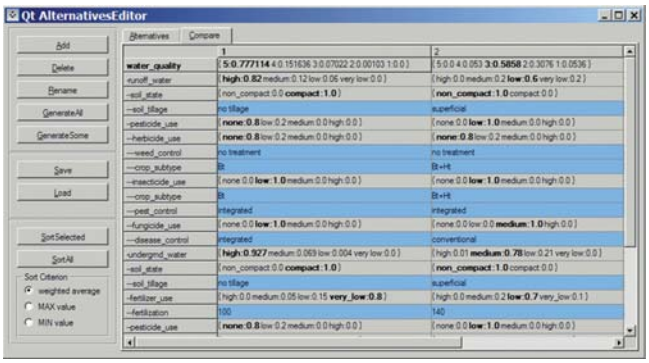


*Figure 4: Using a probabilistic model of proDEX for decision support.*

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51. Jerneja Žganec Gros, Aleš Mihelič, Mario Žganec, France Mihelič, Simon Dobrišek, Janez Žibert, Špela Vintar, Tomo Korošec, Tomaž Erjavec, Miro Romih: Initial considerations in building a speech-to-speech translation system for the Slovenian-English language pair. Practical applications of machine translation: conference proceedings, Budapest, Faculty of Information Technology, Pázmány Péter Catholic University, 2005, pp. 288-293.
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## TEXTBOOKS AND LECTURE NOTES

1. Marko Bohanec: Data mining and decision support integration: course notes, June 27 - July 5,2005, Ljubljana: (Advanced course on knowledge discovery), Ljubljana, Institut Jožef Stefan, 2005.
2. Sašo Džeroski: Knowledge discovert from environmental data: Ecotechnology programme: lecture notes: Ljubljana, Jozef Stefan Intrnational Postgraduate School, 2005.
3. Sašo Džeroski: Relational data mining and ILP: course notes, June 27 - July 5,2005, Ljubljana: (Advanced course on knowledge discovery), Ljubljana, Institut Jožef Stefan, 2005.
4. Sašo Džeroski: Selected topics from New media and e-science: part of "New media and e-science" MSc programme and "Statistics" MSc programme: fall semester 2004/2005: (Postgraduate courses on Knowledge tehnologies), Ljubljana, Jozef Stefan Intrnational Postgraduate School, 2005.
5. Sašo Džeroski, Marko Bohanec: Data mining and decision support for environmental applications: introductory couse for SIGMEA partners: lecture notes: Ljubljana, Jožef Stefan Institute, Department of Intelligent Systems, 2005.
6. Sašo Džeroski, Tomaž Erjavec, Jerneja Žganec Gros: New media and language technologies: lecture notes: part of "New media and e-science" MSc programme, 2004/2005: (Postgraduate courses on Knowledge tehnologies), Ljubljana, Jozef Stefan Intrnational Postgraduate School, 2005.
7. Marko Grobelnik, Dunja Mladenić: web mining: course notes, June 27 - July 5,2005, Ljubljana: (Advanced course on knowledge discovery), Ljubljana, Institut Jožef Stefan, 2005.
8. Nada Lavrač: Data mining: course notes, June 27 - July 5,2005, Ljubljana: (Advanced course on knowledge discovery), Ljubljana, Institut Jožef Stefan, 2005.
9. Nada Lavrač: Data mining and knowledge discovery: part of "New media and e-science" programme: fall semester, 2004/2005: (Postgraduate courses in new media and e-science), Ljubljana, Jožef Stefan Institute, 2005.
10. Nada Lavrač: Rule induction: course notes, June 27 - July 5,2005, Ljubljana: (Advanced course on knowledge discovery), Ljubljana, Institut Jožef Stefan, 2005.
11. Nada Lavrač, Mitja Jermol, Tanja Urbančič, Dunja Mladenić: New media and knowledge management: part of "New media and e-science" programme and "statistics" programme: fall semester, 2004/2005: (Postgraduate courses in new media and e-science), Ljubljana, Jožef Stefan International Postgraduate School, Jožef Stefan Institute, 2005.
12. Dunja Mladenić, Marko Grobelnik: Text mining: course notes, June 27 - July 5,2005, Ljubljana: (Advanced course on knowledge discovery), Ljubljana, Institut Jožef Stefan, 2005.
13. Ljupčo Todorovski: Evaluation methodology: course notes, June 27 - July 5,2005, Ljubljana: (Advanced course on knowledge discovery), Ljubljana, Institut Jožef Stefan, 2005.

## THESES

### Ph. D. Theses

1. Aleks Jakulin: Machine learning based on attribute interactions (Prof. Ivan Bratko)
2. Matjaž Bevk: Feature extraction from textures with association rules (Prof. Igor Kononenko)

# INTERNATIONAL PROJECTS

1. Inductive Queries for Mining Patterns and Models
   IQ
   6. FP; 516169
   EC; prof. dr. Sašo Džeroski, Institut "Jožef Stefan", Ljubljana, Slovenia
   Prof. Sašo Džeroski
2. Knowledge Base for RTD Competencies
   IST-WORLD
   6. FP; 015823
   EC; Leonie Schaefer, Michael Ziegler, Deutsches Forschungszentrum für Künstliche Intelligenz GmbH, Kaiserslautern, Germany
   Marko Grobelnik, Mitja Jermol
3. Central European Centre for Women and Youth in Science
   CEC-WYS
   6. FP; SAS6-CT-2004-003582
   EC; Dr. Marcela Linková, Institute of Sociology, Academy of Sciences of the Czech Republic, Prague, Czech Republic
   Asst. Prof. Dunja Mladenič, Mitja Jermol
4. Semantically-Enabled Knowledge Technologies
   SEKT
   6. FP; 506826
   EC; John Davies, British Telecommunications plc, London, Great Britain
   Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol
5. European Collaborative networked Organizations LEADership initiative
   ECOLEAD
   6. FP; 506958
   EC; Martin Ollus, Technical Research Centre of Finland, Espoo, Finland
   Prof. Nada Lavrač, Mitja Jermol
6. Sustainable Introduction of GMOs into European Agriculture
   SIGMEA
   6. FP; SSPE-CT-2004-501986
   EC; Jeremy Sweet, NIAB, Cambridge, Great Britain
   Prof. Sašo Džeroski
7. Superpeer Semantic Search Engine
   ALVIS
   6. FP; 002068
   EC; Wray Buntine, Complex Systems Computation Group at Helsinki Institute for Information Technology, Helsinki University of Technology, Espoo, Finland
   Asst. Prof. Dunja Mladenič, Marko Grobelnik, Prof. Matjaž Gams
8. Pattern Analysis, Statistical Modelling and Computational Learning
   PASCAL
   6. FP; 506778
   EC; Eileen Simon, The University of Southampton, School of Electronics and Computer Science, Highfield, Southhampton, Great Britain
   Asst. Prof. Dunja Mladenič, Mitja Jermol
9. KD-ubiq - A Blueprint for Ubiquitous Knowledge Discovery
   KD-ubiq
   6. FP; 021321
   EC; Dr. Michael May, Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung E.V., München, Germany
   Asst. Prof. Dunja Mladenič, Marko Grobelnik
10. Soil Ecological and Economic Evaluation of Genetically Modified Crops
    ECOGEN
    5. FP; QLK5-CT-2002-01666
    EC; Dr. Paul Henning Krogh, National Environmental Research Institute, Department of Terrestrial Ecology, Soil Fauna and Ecotoxicology Research Unit, Silkeborg, Denmark
    Prof. Sašo Džeroski
11. Knowledge Management in Medicine and Health Care
    BI-CZ/04-05-008
    Prof. Olga Štepankova, Tomaš Vlček, Jan Rauch, Czech Technical University in Prague, Faculty of Electrical Engineering, Prague, Czech Republic
    Prof. Nada Lavrač
12. Intelligent Data Analysis
    PROTEUS
    Dr. Michele Sebag, Laboratoire de Rechereche en Informatique UMR 8623, Universite de Paris Sud, Orsay Cedex, France
    Prof. Nada Lavrač
13. Intelligent Data Analysis
    BI-HR/04-05-014
    Dr. Dragan Gamberger, Institut "Ruđer Bošković", Zagreb, Croatia
    Prof. Nada Lavrač
14. Automatic Classification of Slovenian and Croatian Web Documents
    BI-HR/05-06-003
    Jasminka Dobša, Fakultet organizacije i informatike, Varaždin, Croatia
    Asst. Prof. Dunja Mladenič
15. Gathering, Annotation and Analysis of Macedonian/Slovenian Language Resources
    BI-MK/05-06-002
    Dr. Katerina Zdravkova, Faculty of Natural Sciences and Mathematics, Skopje, Macedonia
    Prof. Sašo Džeroski
16. Using Artificial Intelligence in Text and Web Mining
    BI-SCG/05-06-019
    Prof. Mirjana Ivanović, Faculty of Science, University of Novi Sad, Novi Sad, Serbia and Montenegro
    Asst. Prof. Dunja Mladenič
17. Development of Slovene and Serbian Language Resources for Machine Translation
    BI-SCG/04-05-001
    Krstev Cvetana, Filološki fakultet, Univerzitet u Beogradu, Vitas, Duško Matematički fakultet Univerzitet u Beogradu, Belgrade, Serbia and Montenegro
    Dr. Tomaž Erjavec

# R & D GRANTS AND CONTRACTS

1. Processing lidar data (Development and use of algorithms for mapping and estimating forest biomass and stand structure from LIDAR data and digital multispectral images)
   Asst. Prof. Sašo Džeroski
2. Linguistic resources for Slovene
   Marko Grobelnik
3. Digital Critical Editions of Slovene Literature
   Dr. Tomaž Erjavec
4. Semantic GRID environment for ecological modelling
   Dr. Ljupčo Todorovski
5. Setting up resources and systems for simultaneous Slovene-English translation
   Dr. Tomaž Erjavec, Prof. Matjaž Gams
6. Setting up a Slovene corpus network
   Dr. Tomaž Erjavec
7. Forecasting GIS for natural environment fire hazards
   Asst. Prof. Sašo Džeroski
8. VoiceTRAN: Multilingual mobile speech communicator for 21th century warriors
   Dr. Tomaž Erjavec

# RESEARCH PROGRAM

1. Knowledge technologies
   Prof. Nada Lavrač

# VISITORS FROM ABROAD

1. Iiro Salkari, VTT, Helsinki, Finland, 30. 01.–2. 02. 2005
2. Toni Jarimo, VTT, Helsinki, Finland, 30. 01.–2. 02. 2005
3. Jiri Hodik, Czech Technical University, Praga, Czech Republic, 30. 01.–2. 02.2005
4. mag. Jasminka Dobša, FOI Varaždin, University of Zagreb, Croatia, 09.–13. 05. 2005
5. dr. Danijel Radošević, FOI Varaždin, University of Zagreb, Croatia, 09.–13. 05. 2005
6. dr. Filip Železny, Technical University, Praga, Czech Republic, 19.–23. 02. 2005
7. Jens Hartmann, University of Karlsruhe, Germany, 19.–23. 02. 2005
8. Marcela Linkova, Institute of Sociology, Academy of Sciences, Praga, Czech Republic, 08. 05. 2005
9. Laura Handerson. Institute of Sociology, Academy of Sciences, Praga, Czech Republic, 08. 5. 2005
10. dr. Dragan Gamberger, Institut Rudjer Bošković, Zagreb, Croatia, 9.–13. 5. 2005
11. prof. Lada Adamić , HP Labs, Palo Alto, USA, 19.–20. 5. 2005
12. prof. Hendrich Blockeel, Katholieke Universiteit Leuven, Belgium, 5. 5. 2005
13. dr. Jan Struyf, Katholieke Universiteit Leuven, Belgium, 4. 4.–3. 6. 2005
14. Leandro Loss, Federal University of Santa Catarina, Florianópolis, Brazil, 9. 6. 2005–31. 1. 2006
15. Martin Kejkula, Technical University, Praga, Czech Republic, 13.–26. 6. 2005
16. Monika Zakova, Technical University, Praga, Czech Republic, 26. 6.–10. 7. 2005
17. prof. Katerina Cundeva Zdravkova, Prirodoslovno matematična fakulteta, Univerza v Skopju, Skopje, Macedonia, 10.–17. 7. 2005
18. Arbana Kadriu, Prirodoslovno matematične fakultete, Univerze v Skopju, Skopje, Macedonia, 10.–17. 7. 2005
19. Viktor Vojnovski, Prirodoslovno-matematična fakulteta, Univerza v Skopju, Macedonia, Skopje, 24. 7.–6. 8. 2005
20. Johanna Mieleitner, EMPA, Zurich, Switzerland, 28. 8.–4. 9. 2005
21. Gemma Casas-Gerriga, Universitat Politčcnica de Catalunya, Barcelona, Spain, 12. 10.–30. 12. 2005
22. Koraljka Golub, Lund University-Department of Information Technology, Sweden, 25.–31. 10. 2005
23. Anders Ardö, Lund University-Department of Information Technology, Lund, Sweden, 25.–31. 10. 2005

# STAFF

**Researchers**

1. Prof. Marko Bohanec**
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3. Prof. Sašo Džeroski**
4. Asst. Prof. Tomaž Erjavec**
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9. Dr. Damjan Demšar
10. Dr. Aleks Jakulin
11. Dr. Branko Kavšek*
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*13. Dr. Matjaž Bevk, left 17. 12. 2005*

14. Janez Brank, M.Sc.
15. Valentin Gjorgjioski, B. Sc.
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17. Panče Panov, B. Sc.
18. Joel Plisson, B. Sc.
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22. Martin Žnidaršič, B. Sc.

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26. Dr. Igor Mozetič

**Technical and administrative staff**

27. Tina Anžič
28. Milica Bauer, B. Sc.
29. Marko Grobelnik

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

# DEPARTMENT OF INTELLIGENT SYSTEMS E-9

***The Department of Intelligent Systems focuses its activities on the development of methods and techniques of intelligent computer systems, with applications in the areas of the information society, computer science and informatics, the Slovene language and speech processing, and network communication systems. The main research areas are agent technologies, the semantic web, evolutionary computing, machine learning, data mining, search algorithms, decision support, intelligent sensors, distributed supervisory systems, and network voice services. The department collaborates closely with the Faculty of Computer and Information Science of the University of Ljubljana on the joint research programme Artificial Intelligence and Intelligent Systems, led by Prof. Ivan Bratko.***

Head:
***Prof. Matjaž Gams***

The department conducts research in the area of **agent technologies**. Agents are autonomous computer programs that simulate the behaviour of human agents. Our research includes learning, modelling and simulation of intelligent agents and multiagent systems. In 2005 the emphasis was on multiagent learning, more precisely, on the modelling of strategic multiagent behaviour without prior knowledge. We have developed a Multi-Agent Strategy Discovering Algorithm (MASDA), which is able to detect and describe a previously unknown strategic multiagent behaviour. The research was successfully tested on the robotic soccer domain (RoboCup) and will be presented at the leading agent conference AAMAS. We also participated in the European network of excellence Agent Link III, which connects institutions involved in agent-related research. Under this project, we organized The Second Agentlink III Technical Forum, held at the Jožef Stefan Institute from 28 February to 2 March 2005.

The **semantic web** is an upgrade to the existing world wide web, where the information is assigned unambiguous, computer comprehensible metadata that facilitate the cooperation between humans and computers. Metadata are linked together into models of knowledge known as ontologies. An ontology represents a graph of semantically related concepts encoded in a computer readable form. One of the basic goals of the semantic web is to automate the generation of ontologies from heterogeneous web sources. A significant contribution of our research in this field is a novel method of automatic generation of ontologies from web tabular structures. The method is incorporated in the TARTAR system and is based on the Hurst formal cognitive table model, where tabular structures are handled at four levels, i.e., physical, structural, functional, and semantic. The TARTAR system is being integrated into a semantic search engine, under development in the EU IST project ALVIS (Superpeer Semantic Search Engine, IST-1-002068-STP).

**The TARTAR system for automatic generation of ontologies from Web tabular structures is being integrated into a semantic search engine under development in the EU IST project ALVIS (Superpeer Semantic Search Engine).**

The ALVIS project is concerned with the design of a new, topic-specific, **open source semantic-based search engine** that will be distributed on a peer-to-peer basis. This approach provides better foundations for semantic web operations, and represents a European reply to dominating US search engines, such as Google. The system will be capable of a deep linguistic analysis where a probabilistic document model will provide a principled evaluation of relevance to complement existing standard authority scores. Our role in the project is to enhance the search by incorporation of advanced machine learning methods for document classification, in particular into genres and topics.

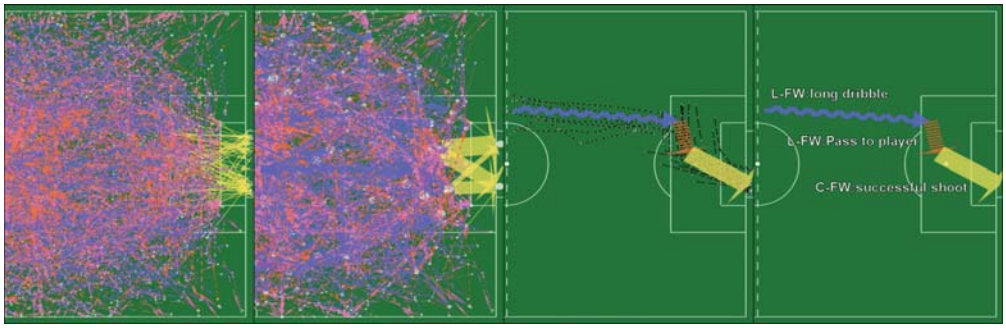


*Figure 1: The MASDA algorithm learns strategic concepts from observing agents in RoboCup soccer games.*

**Evolutionary computation** is a study of search and optimization algorithms imitating the concepts of Darwinian evolution and genetic variation in exploration of complex problem spaces. In this field, we focused on multiobjective optimization, applications of evolutionary algorithms in EPR spectroscopy, and process parameter optimization in continuous casting of steel. We developed DEMO, an evolutionary algorithm for multiobjective optimization based on differential evolution. It is less complex than other multiobjective optimization algorithms and provides comparable, in some cases even favorable, results on test problems. In 2005, the approach was extended towards machine learning with the focus on handling the classification accuracy and complexity of the induced concepts as conflicting criteria. In interdisciplinary research on the applicability of evolutionary computation in EPR spectroscopy, conducted in collaboration with the Laboratory of Biophysics of the Solid State Physics Department at the Jožef Stefan Institute, we improved a genetic algorithm for estimation of EPR spectral parameters in such a way that it is capable of supporting spectroscopic analyses of systems with numerous spectral domains, such as tissues and cell membranes. The method was implemented in software to support laboratory diagnostic tests and presented in two publications in the Journal of Chemical Information and Modeling. Optimization of process parameters in continuous casting of steel was performed under the multilateral project COST 526 (APOMAT) and Slovenian-Finnish collaboration with the University of Oulu, Finland.

**In interdisciplinary research of applied evolutionary computation conducted in collaboration with the Laboratory of Biophysics of the Solid State Physics Department at the Jožef Stefan Institute, we developed a genetic algorithm for parameter estimation in EPR spectroscopy of tissues and cell membranes.**

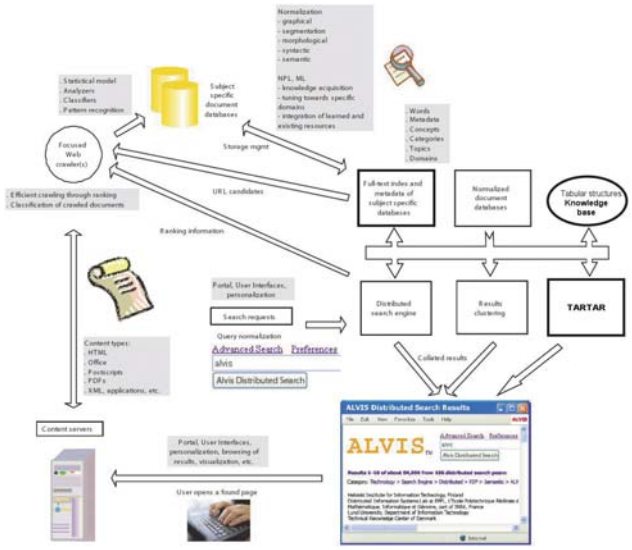


*Figure 2: The TARTAR system represents a part of the ALVIS semantic search engine designed to compete with American search engines, such as Google.*

In the area of **speech and language technologies** we developed new language resources for the Slovene language, new algorithms and procedures for Slovene speech synthesis, and were engaged in syntactic parsing of Slovene text. We inspected the performance of humans (human volunteers, human experts and expert-defined rules) and machines (machine learning methods and n-gram Markov models) on the task of accent assignment of Slovene words. We analyzed the relation between human knowledge and their rules and compared the results of expert-defined rules and machines to find the best method for automatic accentuation of Slovene words. We found that humans tend to accentuate the words correctly, even when they have never heard or seen them before. On the other hand, expert-defined rules for accentuation perform quite poorly, achieving worse results than machines. This indicates that humans are good at accentuating, but very limited in formalizing their knowledge. Therefore, machine methods should be employed in automatic accentuation of Slovene words. In cooperation with other research groups we have continued with development of the syntactically annotated corpus of Slovene text (Slovene Dependency Treebank). Its current size is about 35,000 words. The corpus is intended to serve in the research of automatic syntactical parsing of Slovene text.

In 2005, research in **automatic categorization of text documents** based on character subsequences was also pursued at the department. Such methods have applications in computer security, since they are particularly effective when the text contains noise, either due to errors in the text or intentional obfuscation. A system for filtering malicious and spam email was developed, and proved more effective than established open source and commercial systems in comparative evaluations. Methods that consider the structural form of documents for classification were also researched. It was shown that such methods can substantially improve classification performance.

**A system for filtering malicious and spam email was developed, and proved more effective than established open-source and commercial systems in comparative evaluations.**

We investigated **computer game-playing**, particularly the problems with applications outside the area. We explained many cases of pathological behaviour of the Minimax algorithm and are now extending our analysis to other search algorithms. We presented our new findings at IJCAI 2005, the world's most pretigious AI conference. We also developed a general Bayesian decision model and successfully tested it on card-game bidding.

In computer and communications technology development we concentrated on the issues of mission-critical voice communication over convergent LAN/WLAN networks. This work is part of the EU FP6 IST project WINDECT (Wireless Local Area Network with Integration of Professional Quality DECT Telephony) aimed at providing high-quality **speech service in converged voice/data enterprise networks.** The WINDECT approach is based on grafting of well established professional-quality wireless telephony standard DECT into WLAN standards. In this way, the

project plans to integrate the best of the two worlds of mobile communication: the excellence of DECT for mobile voice applications with the excellence of WLAN for mobile data support. Our role in the project is to demonstrate and test the new solution. We developed a flexible test-bed for voice-quality testing of both commercial VoIP and planned WINDECT solutions. A WINDECT based wireless network will also be demonstrated and tested in the real-user environment of the Slovenj Gradec General Hospital. In this way, future devices will integrate real-time voice/video traffic and packet data.

A traditional activity of the Department of Intelligent Systems is the organization of the International Multiconference Information Society. In October 2005, the 8th multiconference was held in Ljubljana, consisting of six independent conferences.

## Some outstanding publications in the past three years


1. M. Luštrek, M. Gams, I. Bratko, Why Minimax works: an alternative explanation. V: L. P. Kaelbling, A. Saffiotti (ur.). IJCAI-05: Proceedings of the Nineteenth International Joint Conference on Artificial Intelligence, Edinburgh, Scotland, July 30 – August 5, 2005. Denver: International Joint Conferences on Artificial Intelligence, 2005, 212–217
2. A. A. Kavalenka, B. Filipič, M. A. Hemminga, J. Štrancar, Speeding up a genetic algorithm for EPR-based spin label characterization of biosystem complexity, Journal of Chemical Information and Modeling, 45 (2005) 6, 1628–2635
3. G. Gantar, K. Kuzman, B. Filipič, Increasing the stability of the deep drawing process by simulation-based optimization. J. Mater. Process. Technol. (2005) 164/165, 1343-1350
4. T. Šef, M. Gams, Data mining for creating accentuation rules, Applied Artificial Intelligence, 17 (2004) 5, 395–410
5. D. Šuc, D. Vladušič, I. Bratko, Qualitatively faithful quantitative prediction, Artificial Intelligence, 158 (2004) 2, 189–214


## Awards and appointments

1. Bogdan Filipič: Best presentation award at the COST 526 Final Working Group Meeting, Besançon, France, Project Management Committee, for presentation "The role of optimization methodologies and WG4 in COST 526"

## Organization of conferences, congresses and meetings

1. The Second AgentLink III Technical Forum, Jožef Stefan Institute, 28. 02.- 02. 03. 2005 (coorganizer).
2. 8th International Multiconference Information Society IS 2005; Subconferences: Intelligent Systems, Collaboration and Information Society, Data-Mining and Data-Warehouses, Development and Reengineering of Information Systems, Education in Information Society, Cognitive Science, Jožef Stefan Institute, Ljubljana, Slovenia, 11.-17. 10. 2005

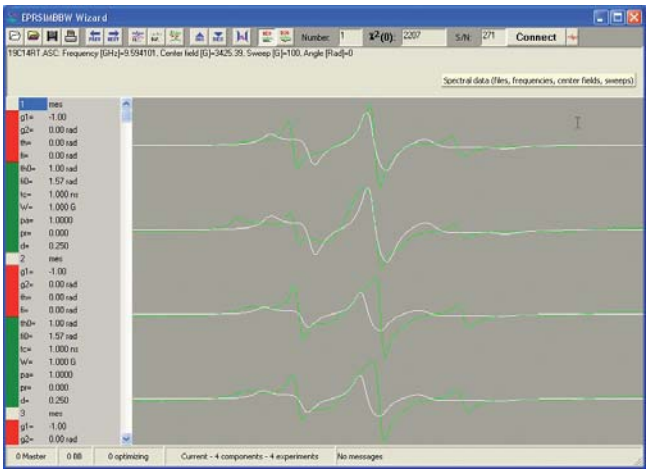


*Figure 3: A genetic algorithm for parameter estimation in EPR spectroscopy was developed in collaboration with the Laboratory of Biophysics, Solid State Physics Department.*


*Figure 4: Visualization of spam filtering. Each character is coloured according to how it is perceived by the filter: Red indicates spam, green indicates good email.*

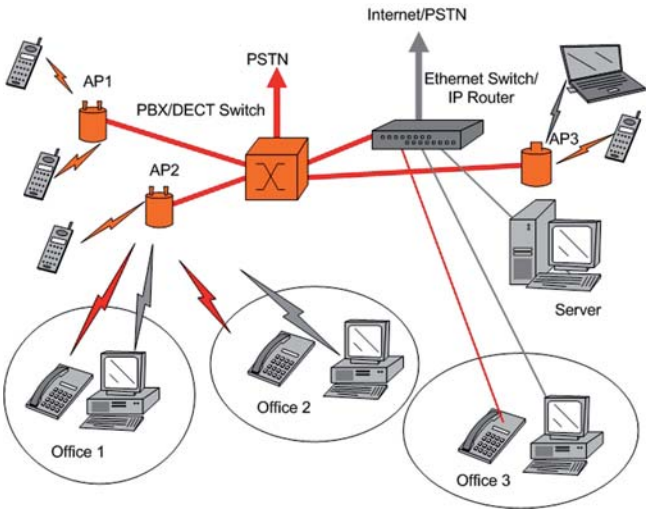


*Figure 5: A converged communication network is being developed under the European project WINDECT.*

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## ORIGINAL ARTICLES


1. Tanja Arh, Vladislav Rajkovič, Borka Jerman-Blažič: Tehnološko podprto izobraževanje - uporabnost in primernost sistemov za upravljanje e-izobraževanja. Vzgoja in izobraževanje v informacijski družbi(Organizacija, Letn. 38, 2005, No. 8), Vladislav Rajkovič, ed., Tanja Urbančič, ed., Mojca Bernik, ed., Kranj, Moderna organizacija, 2005, pp. 386-393.
2. Andraž Bežek, Matjaž Gams: From basic agent behavior to strategic patterns in a robotic soccer. Informatica (Ljubl.), Vol. 29, no. 4, pp. 461-468, 2005.
3. Tomaž Curk, Janez Demšar, Xu Qikai, Gregor Leban, Uroš Petrovič, Ivan Bratko, Gad Shaulsky, Blaž Zupan: Microarray data mining with visual programming. Bioinformatics (Oxf., Print), Vol. 21, no. 3, pp. 396-398, 2005.
4. Bogdan Filipič, Erkki Laitinen: Model-based tuning of process parameters for steady-state steel casting. Informatica (Ljubl.), Vol. 29, no. 4, pp. 491-496, 2005.
5. Gašper Gantar, Karl Kuzman, Bogdan Filipič: Increasing the stability of the deep drawing process by simulation-based optimization. J. mater. process. technol., Vol. 164/165, pp. 1343-1350, 2005.
6. Vida Gönc, Vladislav Rajkovič, Olga Šušteršič: Perspektiva: študij zdravstvene nege na daljavo. Vzgoja in izobraževanje v informacijski družbi(Organizacija, Letn. 38, 2005, No. 8), Vladislav Rajkovič, ed., Tanja Urbančič, ed., Mojca Bernik, ed., Kranj, Moderna organizacija, 2005, pp. 465-470.
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## REVIEW ARTICLES AND CHAPTERS IN BOOKS


1. Mojca Bernik, Igor Bernik, Vladislav Rajkovič: Using knowledge discovery in databases for human resource management decisions. Personnel and management: selected topics, Jože Florjančič, ed., Björn Willi Paape, ed., Frankfurt am Main [etc.], P. Lang, 2005, pp. 97-103.
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### Regular Papers


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5. Janko Černetič, Robert Blatnik: Human-centred collaborative system supporting JIT delivery in manufacturing. Preprints of the 16th IFAC World Congress: Prague, Czech Republic, July 3-8,2005, P. Horacek, ed., M. Simandl, ed., P. Zitek, ed., [Prague], IFAC, 2005, 6 pp.
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35. Tea Tušar, Andrej Bratko, Matjaž Gams, Tomaž Šef: Comparison between humans and machines on the task of accentuation of Slovene words. Zbornik 8. mednarodne multikonference Informacijska družba IS 2005, 11. do 17. oktober 2005(Informacijska družba), Olga Markič, ed., Matjaž Gams, ed., Urban Kordež, ed., Marjan Heričko, ed., Dunja Mladenić, ed., Marko Grobelnik, ed., Ivan Rozman, ed., Vladislav Rajkovič, ed., Tanja Urbančič, ed., Mojca Bernik, ed., Marko Bohanec, ed., Ljubljana, Institut "Jožef Stefan", 2005, pp. 353-356.
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38. Eva Jereb, Lucija Zupan, Vladislav Rajkovič: Sodobni pristopi k izobraževanju s področja informacijske varnosti. Sinergija metodologij: zbornik 24. mednarodne konference o razvoju organizacijskih znanosti, Slovenija, Portorož, 16. - 18. marec 2005: proceedings of the 24th International Conference on Organizational Science Development, Slovenia, Portorož, March 16 -18, 2005, Jindřich Kaluža, ed., Kranj, Moderna organizacija, 2005, pp. 165-173.

## TEXTBOOKS AND LECTURE NOTES

1. Ivan Bratko: Learning from noisy data: course notes, June 27 - July 5,2005, Ljubljana: (Advanced course on knowledge discovery), Ljubljana, Institut Jožef Stefan, 2005.
2. Bogdan Filipič: Stochastic search methods: course notes, June 27 - July 5,2005, Ljubljana: (Advanced course on knowledge discovery), Ljubljana, Institut Jožef Stefan, 2005.

## THESES

### Ph. D. Thesis

1. Aleksander Pivk: Automatic ontology generation from web tabular structures (Prof. Vladislav Rajkovič; research mentor Prof. Matjaž Gams)

### M. Sc. Thesis

1. Simon Rozman: HNM based speech synthesis (Prof. Dušan Kodek)

## INTERNATIONAL PROJECTS

1. Superpeer Semantic Search Engine
   ALVIS; 6. FP; 002068
   EC; Wray Buntine, Complex Systems Computation Group at Helsinki Institute for Information Technology, Helsinki University of Technology, Espoo, Finland
   Prof. Matjaž Gams, Dr. Dunja Mladenič, Marko Grobelnik
2. Wireless Local Area Network with Integration of Professional-Quality DECT Telephony
   WINDECT; 6. FP; 506746
   Technical manager of the project: dr. Eva Ravnikar, Ascom AG, Switzerland
   Business manager of the project: Hans-Peter L. Bauer Winfinity GmbH, Kiel, Germany
   Dr. Marjan Špegel

3. Automatic Process Optimization in Materials Technology (APOMAT)
   COST 526
   3311-03-837079
   EC; Dr. Fredy Hediger, Access, Aachen, Germany
   Asst. Prof. Bogdan Filipič
4. Numerical Optimization of Continuous of Steel
   BI-FI/04-05-009
   Dr. Erkki Laitinen, Department of Mathematical Sciences, University of Oulu, Oulu, Finland
   Asst. Prof. Bogdan Filipič
5. Securing and Optimising Smart Access and Personal Identification Systems with Intelligent Agents
   BI-RO/05-06/016
   Dr. Madalin Stefan Vlad, Politehnica University of Bucharest, Bucharest, Romania
   Prof. Matjaž Gams

# R & D GRANTS AND CONTRACTS

1. Computer System for Voice Information
   Prof. Matjaž Gams
2. Integrated Multi-Media Mobile Applications in Hospitals
   Prof. Matjaž Gams
3. Technology of learning in multi-agent systems
   Prof. Matjaž Gams
4. Automatic Speech Recognition and Synthesis System for Slovenian Language
   Dr. Tomaž Šef
5. Automatic Speech Translation
   Prof. Matjaž Gams
6. Forensic Speaker Identification
   Dr. Tomaž Šef
7. Professional System for Mobile Communications for Ministry of Defense
   Dr. Marjan Špegel

# RESEARCH PROGRAM

1. Artificial Intelligence and Inteligent Systems
   Prof. Ivan Bratko, Academician

# VISITORS FROM ABROAD

1. Catherine Atherton, University of Liverpool, United Kingdom, 28. 02.–02. 03. 2005
2. Prof. Marcin Paprzycki, Oklahoma State University, Tulsa, USA, 07.–08. 04. 2005
3. Dr. Wray Buntine and Mikko Kontainen, Helsinki Institute of Information Technology, Finland, 07. 06. 2005
4. Prof. Sergey Psakhie, Tomsk Science Center, Tomsk, Russia, several one-day visits

# STAFF

**Researchers**

1. Prof. Ivan Bratko*, Academician
2. Asst. Prof. Bogdan Filipič**
3. **Prof. Matjaž Gams**, Head**
4. Dr. Tomaž Šef
5. Dr. Marjan Špegel

**Postdoctoral associates**

6. Dr. Aleš Dobnikar***
7. Dr. Matija Drobnič***
8. Dr. Viljem Križman***
9. Dr. Aleksander Pivk

**Postgraduates**

10. Andraž Bežek, M. Sc.
11. Andrej Bratko***, B. Sc.
12. Mitja Luštrek, B. Sc.
13. Domen Marinčič, M. Sc.
14. *Simon Rozman***, B. Sc., left 31. 12. 2005*
15. Tea Tušar, B. Sc.

**Technical officers**

16. Robert Blatnik, B. Sc.
17. Dr. France Dacar
18. Peter Reinhardt***, B. Sc.

**Technical and administrative staff**

19. Milica Bauer, B. Sc.
20. Mitja Lasič
21. Liljana Lasič

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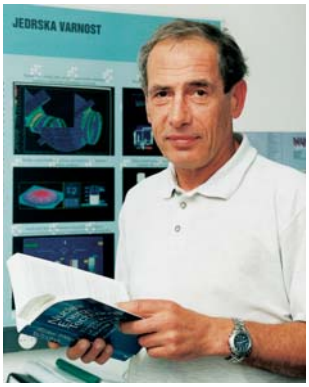
** Part-time faculty member
*** Member of industrial or other organisation

# 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 modelling of basic thermal-hydrodynamic phenomena, thermal-hydraulic safety analyses of design-basis and severe accidents, structural safety analyses and probabilistic safety assessment. Most research activities are part of international cooperation programs. Research results are incorporated in projects for industry and for regulatory authorities.***




Head:
***Prof. Borut Mavko***

### Modelling of basic thermal-hydrodynamic phenomena

Numerical simulations of heat transfer in turbulent flow at high Prandtl number near a heated flat wall were carried out. Simulations are based on so-called Direct Numerical Simulation that models all characteristic length and time scales in a given velocity field, and on models of turbulent thermal conductivity, which is used to simulate the smallest temperature scales that cannot be resolved at high Prandtl numbers with the given resolution. Results have shown the negligible influence of the smallest structures of the turbulent thermal field.

In the field of subcooled boiling simulations, the development of a two-fluid Eulerian model, where phases are described with separate sets of transport equations, is being continued. The main activities were carried out within the 6th EU Framework Programme (FP) project NURESIM. In collaboration with Forschungszentrum Rossendorf (Germany), numerical simulations of high-pressure boiling experiments in vertical channels at conditions characteristic for pressurised water reactors were performed with the Computational Fluid Dynamics code CFX. The simulations have shown that the evolution of the two-phase flow structure in subcooled boiling is influenced mainly by mechanisms in the wall boundary layer.

**Simulations of heat transfer in turbulent flow near a heated flat wall were performed using Direct Numerical Simulation.**

The computer code WAHA, which was developed within the WAHALoads project of the 5th EU FP to simulate transients in piping systems, is being upgraded with a model that will enable a two-way coupling between the thermal-hydrodynamic phenomena in the pipe and the reactions of the flexible piping structure.

The CFX code is being used as a platform for the development of a model for inter-phase transfer of heat, mass, and momentum, in a horizontally stratified flow of cold liquid and hot steam. This research is being performed within the NURESIM project.

A steam explosion might occur during a hypothetical severe accident in a nuclear power plant if the molten reactor core pours into the water in the reactor cavity. The influence of the melt liquidus and solidus temperatures on the steam explosion premixing and explosion phases were analysed using the European code MC3D. In 2006 we will perform an experiment on steam explosions with prototypic corium using the KROTOS facility at the Commissariat à l' Energie Atomique (CEA), France. In the preparation phase, we defined the corium composition and the experimental conditions. These activities are being carried out within the SARNET Network of Excellence (6th EU FP).

In the field of heat-exchanger modelling, time distributions of velocity and temperature fields were obtained from numerical simulations of heat transfer in a heat-exchanger segment with cylindrical, ellipsoidal and wing-formed internal solid structures. Separately from the numerical thermal-hydraulic model, a semi-analytical model was developed based on the Galerkin method. Calculations were performed for air flow across a solid structure and water flow across a bundle of cylindrical rods with internal heat generation, which is quite common in the nuclear industry.

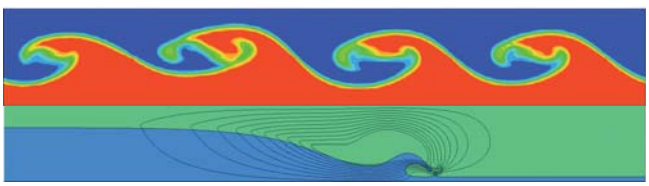


*Figure 1: Simulations of stratified flows*
*a) Volume fraction of the heavier liquid in the simulation of Kelvin-Helmholtz instability, which appears in counter-current flow of two immiscible liquids at large relative velocity.*
*b) Streamlines of dam-break simulation calculated with the level-set method; blue: water, green: air.*

### Thermal-hydraulic safety analyses

Methods for estimating the dynamic behaviour of a nuclear power plant under accident conditions, including uncertainty evaluation, were analysed. For quantitative assessment, the time invariant Fast Fourier Transform Based Method (FFTBM) was developed to extend its applicability to simulations of severe accidents. The developed method was applied to the simulation of the test FPT1 (performed on the Phebus facility in Cadarache, France) with the MELCOR code. The accuracy was also investigated for large-break loss-of-coolant calculations performed on the

RD-14M facility that simulates a CANDU heavy-water reactor. The quantitative assessment was compared to assessments performed in the frame of the International Atomic Energy Agency (IAEA) Technical working group on advanced technologies for heavy-water reactors.

In the field of modelling of containment phenomena, which is also part of the activities being carried out within the SARNET network, a three-dimensional simulation of an experiment on containment atmosphere mixing and stratification was carried out. The experiment was performed in the ThAI facility, which is located at Becker Technologies in Eschborn (Germany). Experiments on aerosol behaviour, which were performed on the KAEVER facility (also at Becker Technologies), were simulated with the European code for severe accident simulation ASTEC.

**Structural safety analyses**

The development of tools for multiscale simulation of polycrystalline materials was further continued. The major advance was the successful implementation of tools simulating short cracks crossing a grain boundary. In general, the development of multiscale simulation tools followed two primary goals: prediction of the complex response of a polycrystalline aggregate based on the known properties of a monocrystal, and prediction of initiation and propagation of microscopic defects, including the impact on macroscopic material properties. The random grain structure is represented by an incomplete random tessellation (Voronoi tessellation). The microscopic stress fields in randomly oriented and shaped grains are then obtained using the finite element solver ABAQUS. The research is being carried out in cooperation with the EU Joint research centre Petten (The Netherlands), Forschungszentrum Karlsruhe (Germany) and AIB-Vinçotte Nucléaire (Belgium).

**Multiscale simulations of polycrystalline materials are implemented to predict the initiation and propagation of microscopic defects.**

Important progress has also been achieved through the development of a simulation for projectiles impacting ceramic armour plates. The purpose is to assess the degree of protection provided by the plate.

**Probabilistic safety assessment**

A new method for human reliability analysis in complex systems was developed. The pre-initiators and post-initiators were considered separately in a systematic framework, which includes the process of evaluation of human performance and the associated impact on structures, systems and components for a complex facility. Dependencies between consecutive human failure events were considered.

The development of a method for assessing network reliability was initiated. The fault tree analysis was applied in a new way, which enables assessment of network reliability taking into consideration the structure of the network and its components.

In the field of equipment vulnerability assessment, selected combinations of failures of components, systems and structures were evaluated. The inputs for selecting combinations were taken from structural analyses based on the magnitude of pressure shock waves and strain energy.

**A method for human reliability assessment was developed, with emphasis on dependencies between separate human failure events.**

The research is being carried out within the SAFERELNET project (5th EU FP) and in cooperation with Tsinghua University (China), the Technical University of Ostrava (Czech Republic) and the Polytechnic University of Valencia (Spain).

**Technical cooperation, consulting services, and education**

In 2005, Reactor Engineering Department researchers also cooperated in projects for industry and the state administration. We took an active part in the periodic safety review of structures, systems and components of the Krško nuclear power plant. The review represents the basis for the nuclear safety assessment of the facility. As an authorized institution for nuclear safety assessment, the JSI issues permits for recriticality and regular operation of the Krško NPP after each regular outage. We also organized the international conference 'Nuclear Energy for New Europe 2005', with more than 200 participants from 24 countries. Members of the Reactor Engineering Department are also actively involved in the nuclear engineering graduate programme at the Faculty of Mathematics and Physics at the University of Ljubljana. The programme is associated with the European Nuclear Education Network (ENEN).

## Some outstanding publications in the past three years

1. L. Cizelj, G. Roussel, Probabilistic evaluation of leak rates through multiple defects: the case of nuclear steam generators, Fatigue & Fracture of Engineering Materials & Structures 26 (2003) 1069-1079.
2. A. Prošek, B. Kvizda, B. Mavko, T. Kliment, Quantitative assessment of MCP trip transient in a VVER, Nuclear Engineering and Design 227 (2004) 85-96.

3. I. Tiselj, A. Horvat, B. Mavko, E. Pogrebnyak, A. Mosyak, G. Hetsroni, Wall properties and heat transfer in near-wall turbulent flow, Numerical Heat Transfer A: Applications 46 (2004) 717-729.
4. B. Končar, I. Kljenak, B. Mavko, Modelling of local two-phase flow parameters in upward subcooled flow boiling at low pressure, International Journal of Heat and Mass Transfer 47 (2004) 1499-1513.
5. A. Horvat, B. Mavko, Hierarchic modeling of heat transfer processes in heat exchangers, International Journal of Heat and Mass Transfer 48 (2005) 361-371.
6. M. Kovač, I. Simonovski, L. Cizelj, Modeling elasto-plastic behavior of polycrystalline grain structure of steels at mesoscopic level, Nuclear Engineering and Design 235 (2005) 1939-1950.
7. M. Čepin, Analysis of truncation limit in probabilistic safety assessment, Reliability Engineering and System Safety 87 (2005) 395-403.

## Patents granted

1. Matjaž Leskovar
   Chain drive train for bicycle or other vehicle with chain
   Patent no. 9400377

## Organization of conferences, congresses and meetings

1. International conference 'Nuclear Energy for New Europe 2005', Bled, Slovenia, 5.-8.9.2005
2. Meeting of European Project NURESIM (Nuclear Reactor Simulations), Bled, Slovenia, 8.-9.9.2005

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## ORIGINAL ARTICLES


1. Bernard Clément, Matjaž Leskovar, (16 authors): Thematic network for a Phebus FPT-1 international standard problem (THENPHEBISP). Nucl. Eng. Des., Vol. 235, pp. 347-357, 2005.
2. Marko Čepin: Analysis of truncation limit in probabilistic safety assessment. Reliab. eng. syst. saf., Vol. 87, pp. 395-403, 2005.
3. Andrej Horvat, Borut Mavko: Calculation of conjugate heat transfer problem with volumetric heat gerenation using the Galerkin method. Appl. math. model., Vol. 29, pp. 477-495, 2005.
4. Andrej Horvat, Borut Mavko: Hierarchic modeling of heat transfer processes in heat exchangers. Int. j. heat mass transfer, Vol. 48, pp. 361-371, 2005.
5. Andrej Horvat, Borut Mavko, Ivan Catton: The Galerkin method solution of the conjugate heat transfer problems for the cross-flow conditions. Stroj. vestn., Vol. 51, no. 7-8, pp. 527-533, 2005.
6. Ivo Kljenak, Borut Mavko: Simulation of void fraction profile evolution in subcooled nucleate boiling in a vertical annulus with a bubble-tracking model. Stroj. vestn., Vol. 51, no. 7-8, pp. 436-444, 2005.
7. Marko Kovač, Igor Simonovski, Leon Cizelj: Modeling elasto-plastic behavior of polycrystalline grain structure of steels at mesoscopic level. Nucl. Eng. Des., Vol. 235, pp. 1939-1950, 2005.
8. Alex Liberzon, Roi Gurka, Iztok Tiselj, Gad Hetsroni: Spatial characterization of the numerically simulated vorticity fields of a flow in a flume. Theor. comput. fluid dyn., Vol. 19, pp. 115-125, 2005.
9. Frans Moons, Joseph Safieh, Michel Giot, Borut Mavko, Bal Raj Sehgal, Anselm Schäfer, Georges Van Goethem, William Denis D'haeseleer: European master of science in nuclear engineering. Nucl. Eng. Des., Vol. 235, pp. 165-172, 2005.
10. Anis Bousbia Salah, Giorgio M. Galassi, Francesco D'Auria, Boštjan Končar: Assessment study of the coupled code RELAP5/PARCS against the peach bottom BWR turbine trip test. Nucl. Eng. Des., Vol. 235, pp. 1727-1736, 2005.
11. Boštjan Končar, Borut Mavko, Ivo Kljenak: Model stenskega uparjanja za popis podhlanejega vrenja toka pri nizkih tlakih. Stroj. vestn., Vol. 51, no. 10, pp. 646-660, 2005.


## REVIEW ARTICLES AND CHAPTERS IN BOOKS


1. Iztok Tiselj, Luka Štrubelj, Ivan Bajsič: Test-case no. 36: Kelvin-Helmholtz instability (PA). Validation of advanced computational methods for multiphase flow(Series in thermal and fluid physics and engineering), Herve Lemonnier, Didier Jamet, Olivier Lebaigue, New York, Begell House, cop. 2005, pp. 291-298.


## PUBLISHED CONFERENCE PAPERS

### Invited Paper


1. Iztok Parzer, Borut Mavko: Recent CAMP activities in Slovenia. Spring 2005 CAMP Meeting: 2-4 May 2005, Dubrovnik, Croatia, Tomislav Bajs, ed., Zagreb, Croatian Nuclear Society, Faculty of Electrical Engineering and Computing, 2005, 38 pp.


### Regular Papers


1. Miroslav Babić, Ivo Kljenak, Borut Mavko: Simulation of atmosphere mixing and stratification in the ThAI experimental facility with a CFD code. Proceedings, International Conference Nuclear Energy for New Europe 2005, September 5-8, 2005, Bled, Slovenia, Borut Mavko, ed., Ivo Kljenak, ed., Ljubljana, Nuclear Society of Slovenia, 2005, 009.1.-009.10.
2. Robert Bergant, Iztok Tiselj: The smallest temperature scales in a turbulent channel flow at high Prandtl numbers. 2005 Summer Heat Transfer Conference (HT2005): 2005 ASME/Pacific Rim Technical Conference and Exhibition on Integration and Packaging of MEMS, NEMS, and Electronic Systems (InterPACK2005): July 17-22, 2005, San Francisco, California, USA, [S.l.], ASME, 2005, 10 pp.
3. Robert Bergant, Iztok Tiselj: Numerical simulation of turbulent flume heat transfer at PR=5.4 - impact of the smallest temperature scales. FEDSM2005, 2005 ASME Fluids Engineering Division Summer Meeting, Houston, Texas, June 19-23, 2005, [New York, NY], ASME, cop. 2005, 8 pp.
4. Robert Bergant, Iztok Tiselj: Numerical simulations of turbulent heat transfer in the channel at Prandtl numbers higher than 100. Proceedings, International Conference Nuclear Energy for New Europe 2005, September 5-8, 2005, Bled, Slovenia, Borut Mavko, ed., Ivo Kljenak, ed., Ljubljana, Nuclear Society of Slovenia, 2005, pp. 018.1-018.10.
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6. Leon Cizelj, Boštjan Končar, Matjaž Leskovar: Vulnerability of a partially flooded PWR reactor cavity to a steam explosion. ICONE 13, The 13th International Conference on Nuclear Engineering: May 16-20, 2005, Beijing, China, [S.l.], Atomic Energy, 2005, 8 pp.
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10. Marko Čepin, Leon Cizelj, Matjaž Leskovar, Borut Mavko: Vulnerability analysis considering explosive devices. International conference on Nuclear Security: global directions for the future: London, United Kingdom, 16-18 March 2005: contributed papers(IAEA-CN-, 136), [Vienna], IAEA, 2005, pp. 31-35.
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12. Janez Gale, Iztok Tiselj: Modeling of pressure undershoot and heat and mass transfer at negative pressures. FEDSM2005, 2005 ASME Fluids Engineering Division Summer Meeting, Houston, Texas, June 19-23, 2005, [New York, NY], ASME, cop. 2005, 8 pp.
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14. Janez Gale, Iztok Tiselj: Applicability of the Godunov's method for fundamental four-equation FSI model. Proceedings, International Conference Nuclear Energy for New Europe 2005, September 5-8, 2005, Bled, Slovenia, Borut Mavko, ed., Ivo Kljenak, ed., Ljubljana, Nuclear Society of Slovenia, 2005, pp. 019.1-019.10.
15. Ivo Kljenak, Miroslav Babić, Borut Mavko, Ivan Bajsič: Modelling of atmosphere mixing and statification in the TOSQAN experimental facility with the CFX code. Conference proceedings, Eleventh International Topical Meeting on Nuclear Reactor Thermal Hydraulics, NURETH 11, October 2-6,2005, Avignon, France, Hervé Lemonnier, ed., [S.l., 2005, 16 pp.
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## THESIS

### Ph. D. Thesis

1. Robert Bergant: Turbulent Heat Transfer near the Flat Wall for High Prandtl Numbers (Iztok Tiselj)

# INTERNATIONAL PROJECTS

1. European Platform for Nuclear Reactor Simulations
   NURESIM; 6. FP; 516560
   EC; Maryline Rougier, CEA Saclay, DEN/DSOE, Gif-Sur-Yvette Cedex, France
   Asst. Prof. Iztok Tiselj, Dr. Andrej Prošek
2. Nuclear European Platform of Training and University Organisations
   NEPTUNO; 6. FP; FI60-CT-2003-508849
   EC; CEA/SACLAY, INSTN / UERTI, Gif-sur-Yvette Cedex, France
   Prof. Leon Cizelj, Prof. Igor Jenčič
3. Network of Excellence for Sustainable Integration of European Research on Severe Accident Phenomenology and Management
   SARNET; 6. FP; FI60-CT-2004-509065
   EC; Institut de radioprotection et de sureté nucléaire, Clamart, France
   Dr. Matjaž Leskovar
4. A Thematic Network for Promoting Best Practice Industrial Application of Finite Element Network
   FENET; 5. FP; GTC2-2000-33057
   EC; Tom Kenny, David Quinn, NAFEMS Ltd, Glasgow, Great Britain
   Prof. Leon Cizelj
5. European Nuclear Education Network
   ENEN; 5. FP, EURATOM; FIR1-CT-2001-80127

EC; Frans Moons, Studiecentrum voor Kernenergie/Centre de l'Energie Nucleaire (SCK-CEN), Mol, Belgium
Prof. Borut Mavko

6. Safety and Reliability of Industrial Products, Systems and Structures
SAFERELNET-NAS; 5. FP; 1/54, GIRT-CT-2001-0501
EC; Prof. Carlos Guedes-Soares, Technical University of Lisbon, Instituto Superior Téchnico, Unit of Marine Technology and Engineering, Lizbona, Portugal
Asst. Prof. Marko Čepin
7. Code Applications and Maintenance Program (CAMP)
Thermal-Hydraulic Code Applications and Maintenance International Research Project
Dr. Andrew J. Szukiewicz, Reactor and Plant Systems Branch, Division of Systems Technology, Office of Nuclear Regulatory Research; dr. Ashok C. Thadani, Director, Office of Nuclear Regulatory Research, United States Nuclear Regulatory Commission (US NRC), Washington, D. C., USA
Prof. Borut Mavko
8. Risk and Cost Limited Optimization of the Maintenance based on Semi-Analytic Stochastic Modeling
BI-CZ/05-06/004
Dr. Radim Briš, Technical University of Ostrava (TUO), Faculty of Electrical Engineering and Computer Science (FEI), Ostrava-Poruba, Czech Republic
Asst. Prof. Marko Čepin
9. PHEBUS Fission Products Agreement
SLO-F-2003-2008
Daniel Queniat, Acting Director, Institut de Radioprotection et de Sureté Nucléaire (IRSN), Clamart, France
Dr. Matjaž Leskovar
10. Multidimensional Modeling of Turbulence and Bubble Dynamics in Boiling Flows
BI-US/04-05/26
Prof. Yassin A. Hassan, Texas A&M University, Department of Nuclear Engineering, College Station, Texas, USA
Dr. Boštjan Končar

# R & D GRANTS AND CONTRACTS

1. Safety Margins in Nuclear Power Plants
Dr. Andrej Prošek
2. Development of New Safety Models and Definition of Risk Criteria
Asst. Prof. Marko Čepin
3. Simulations of Stratified and Slug Flows
Asst. Prof. Iztok Tiselj
4. Modelling of Steam Explosions
Dr. Matjaž Leskovar
5. Modelling of Nonhomogeneous Atmosphere in Nuclear Power Plant Containment
Dr. Ivo Kljenak
6. Three-Dimensional Eulerian Model of Convective Boiling
Prof. Borut Mavko, Dr. Boštjan Končar
7. The Influence of the Mesoscopic Inhomogenities in Materials on the Life-Time of Safety Significant Components of Nuclear Power Plants
Dr. Igor Simonovski
8. Multilayered Penetration Resistant Composites
Prof. Leon Cizelj

# RESEARCH PROGRAM

1. Nuclear Engineering
Prof. Borut Mavko

# NEW CONTRACT

1. Comparison of NEK RCS Response to Different Seismic Input Data
Uprava RS za jedrsko varnost
Prof. Leon Cizelj

# VISITORS FROM ABROAD

1. Mr. Jean-Pierre Le-Roux, Mr. Patric Ledermann, Mr. Gerard Cognet, Mrs. Claire Giry, Mr. Claude Ayaxche and Mr. Jean-Marc Capdevila, Commissariat à l' Energie Atomique (CEA), France, 5.–6. 1. 2005
2. Mr. William Douglas, Brian Cartmell, Beechcroft, Back Lane, Stavely, Kendal, Great Britain, 27. 6.–5. 8. 2005
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4. Dr. Dominique Bestion, CEA, Commissariat à l'Energie Atomique, Grenoble, France, Dr. Antoine Guelfi, Dr. Marc Bouckner, Dr. Alain Martin, Electricité de France, Paris, France, Dr. Gabor Hazi, KFKI, Atomic Energy Research Institute, Budapest, Hungary, Prof. Dr. Michel Giot, Dr. Jean-Marie Seynhaeve, Université Catholique de Louvain, Belgium, Dr. Djamel Lakehal, ASCOMP-ETH, Zurich, Switzerland, Dr. Mikko Ilvonen, VTT, Technical Research Centre, Finland, Dr. Markuu Puustinen, Lappeenranta University of Technology, Finland, Dr. Brian Smith, Paul Scherrer Institute, Villigen, Switzerland, Dr. Dirk Lucas, Dr. Eckart Krepper, E. Bodele, FZR, Forschungszentrum Rossendorf, Germany, Dr. Jirí Macek, NRI, Nuclear Research Institute, Rez, Czech Republic, Dr. Martina Scheurer, GRS, Gesellschaft für Anlagen- und Reaktorsicherheit, Germany, Dr. Fabio Moretti, Davide Mazzini, Universita di Pisa, Italy and Asst. Prof. Henryk Anglart, KTH, Royal Institute of Technology, Stockholm, Sweden, Bled, Slovenia, 8.–9. 9. 2005
5. Dr. Pavel Praks, University of Ostrava, Czech Republic, 3.–13. 10. 2005

# STAFF

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3. Dr. Andrej Horvat
4. Dr. Romana Jordan-Cizelj***
5. Dr. Ivo Kljenak
6. Dr. Matjaž Leskovar
7. **Prof. Borut Mavko**, Head**
8. Dr. Andrej Prošek
9. Prof. Iztok Tiselj**

**Postdoctoral associates**
10. Dr. Boštjan Končar
11. Dr. Igor Simonovski

**Postgraduates**
12. Miroslav Babić, B. Sc.
13. *Robert Bergant, M. Sc., left 1. 12. 2005*
14. Janez Gale, B. Sc.
15. Zoran Petrič, B. Sc.
16. Luka Štrubelj, B. Sc.

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18. Dr. Iztok Parzer
19. Andrej Sušnik, B. Sc.

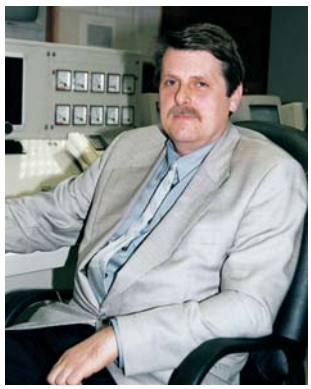
**Technical and administrative staff**
20. Tanja Klopčič
21. Zlata Vrhovec Mikolič

** Part-time faculty member
*** Member of industrial or other organisation

# REACTOR INFRASTRUCTURE CENTRE RIC

***The TRIGA Mark II Reactor at the Jožef Stefan Institute has been operating since 1966. It is used for neutron research, training, and for producing radioactive isotopes. Besides operating and maintaining the reactor, the members of the reactor staff also cooperate in other activities requiring specialists skilled in working with radiation sources and in reactor technology, such as servicing industrial radioactive sources and surveillance of the fuel management at NPP Krško.***

***A detailed technical description of the reactor is available at http://www.rcp.ijs.si/~ric/***



Head:
***Prof. Matjaž Ravnik***

In 2005, the reactor operated 176 days and released 258 MWh of energy. 1706 samples were irradiated, 940 of them in the rotary specimen rack, 324 in the pneumatic post system and 442 in the fast pneumatic post system.

It mainly operated in the steady-state mode. In the pulse mode it produced 10 pulses with identification numbers 165 to 174. Two core modifications were performed for experimental purposes, numbered 187 to 188.

There have been no serious operational problems or events influencing nuclear or radiological safety.

The reactor was mainly used for neutron activation analysis and operated mainly for the needs of the J. Stefan Institute research departments: the Environmental Science department, the Reactor Physics department, the Experimental Particle Physics department and the Department for nanostructured materials. The reactor was used in the following research:

- neutronics and reactor physics
- activation analysis
- neutron dosimetry and spectrometry
- neutron radiography
- activation of materials, nuclear waste and decommissioning
- irradiation of materials for fusion reactors.

The reactor operators support the researchers by performing operations and services for which the researchers are not qualified and authorized, such as operating the reactor, and performing irradiations and manipulation with radioactive samples.

In 2005 they irradiated more than 2000 samples, mainly for studying their activation. The results of this research were published in approximately 20 scientific papers. Three young researchers performed their research projects at the reactor.

Practical exercises for the students of physics at Ljubljana University were performed. The nuclear engineering postgraduate students attended some of these exercises as well. For these purposes the reactor operated approximately 10 days. The reactor was also used for practical exercises within the training program for NPP Krško reactor operators. The exercises were prepared and carried out by the reactor personnel.

Two larger groups of students from the faculties of electrical engineering of Ljubljana and Zagreb Universities (40 and 60 visitors, respectively) visited the reactor, as well as approximately 300 other visitors in smaller groups.

*Figure 1: Irradiation of additives for SiC/SiC composite materials developed at the Department for Nanostructured Materials for the first wall of a future fusion reactor.*

## STAFF

**Technical officers**

1. Bojan Huzjan
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**Administrative staff**

6. Darja Stich

# CENTRE FOR NETWORKING INFRASTRUCTURE CNI

***The basic function of the Centre for Network Infrastructure (CNI) is the management and maintenance of the JSI computer network, including planning, development, upgrades, maintaining contact with public networks, and providing security.***

Head:
***Vladimir Alkalaj, M. Sc.***

Upgrades of the physical network of the JSI LAN remain the most investment-intensive task of the CNI, and are likely to remain so in the future. However, network security has become the most knowledge- and time-intensive task of the CNI.

Increasing traffic invariably involves a growing number of undesirables, such as worms, viruses, break-in attempts, and unsolicited commercial mail (UBE or spam). It is particularly disturbing that the incidence of viruses/worms and spam is growing faster than network traffic. Network protection therefore requires increasingly more powerful interfaces, firewalls and other equipment, as network traffic continues to double every 14 months.

UBE or spam is not just a nuisance, but may be a source of substantial damage. Most commonly, the irritated user beset by hundreds of spam messages may delete important mail while attempting to clean his mailbox. But more importantly, spam may hide spyware or other types of malware.

Unfortunately, spammers are increasingly more inventive – the distribution of UBE is a surprisingly large business. A somewhat inappropriate advertising campaign of AOL managed to illustrate just how big this business is.

In March 2004 AOL initiated a wide-ranging advertising campaign against spam by publicizing that it had won a legal suit against one of the perpetrators of UBE. To scare other like-minded entrepreneurs, AOL illustrated its ads with a photograph of a Porsche Boxter legally sequestered from the said offender – users were supposed to think „'Look what spamming can cost you.' Actually, most of the internet audience were surprised by the possible gains – 'What, one can earn a Porsche Boxter by distributing spam?!?!?' AOL eventually donated the Porsche in an online game, but the campaign definitely did not scare spammers; more likely it encouraged them.

Because the distribution of UBE is such a profitable business, protection against spam is a continuing struggle of new strategies and anti-strategies. Efficient spam filtering is based on scoring schemes which assign e-mails with 'spam points' for individual 'suspicious' characteristics. Such systems leave it to the user to define his own threshold for e-mail he wishes to accept. One of the scoring criteria – constantly updated in accordance with statistical data - is the operating system of the sender.

Whenever a TCP/IP connection is established, the choice of some IP options is left to the operating system which requests the connection. Passive determination of the OS 'fingerprint' frequently allows for quite precise determination of the initiating OS without degrading communications or causing an additional load on the network.

This method was used to establish correlations between the type of remote operating system at e-mail delivery, and the content of the message, the latter being assigned a 'spam score' by SpamAssassin.

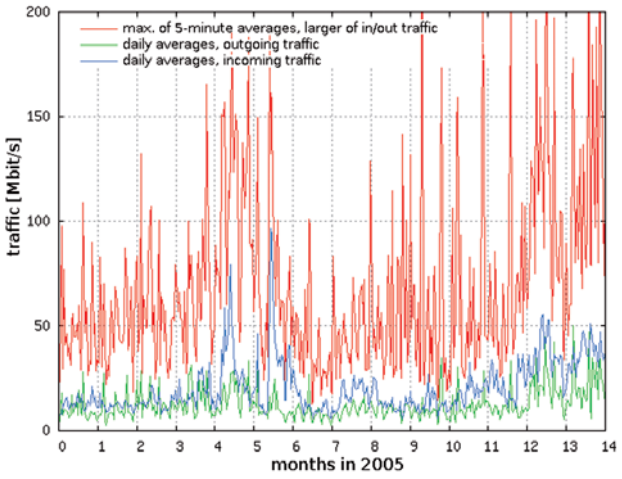


*Figure 1: Distribution of IP traffic in 2005*

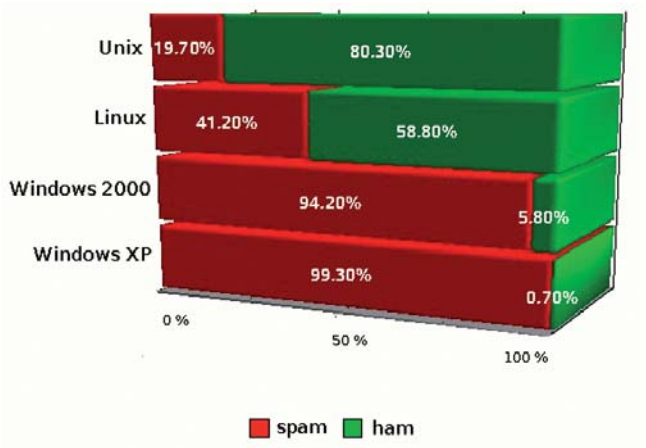


*Figure 2: Distribution of all incoming e-mail during a two-week period at the end of 2005.*

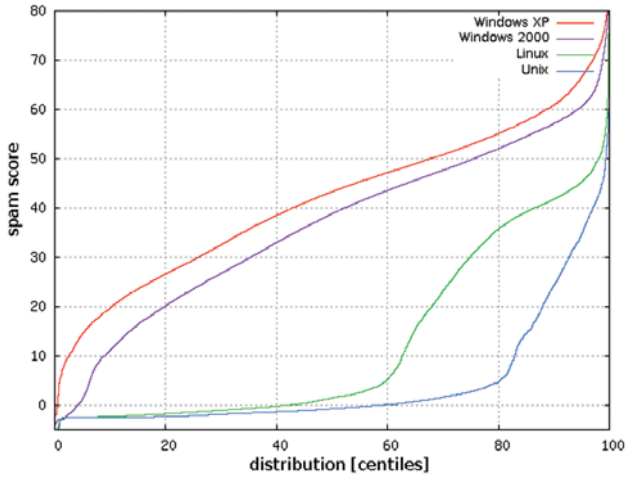


*Figure 3: Distribution of all incoming e-mail during a two-week period at the end of 2005, separated for the most common types of remote operating system. The boundary between regular mail and UBE (spam) is set at 5, close to the steepest part of the curve.*

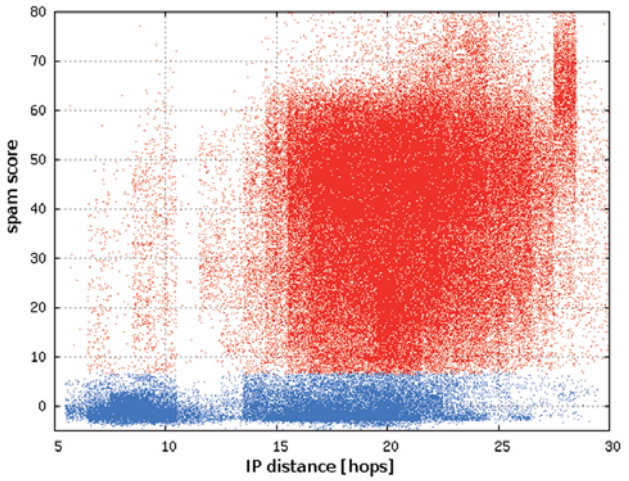


*Figure 4: Distribution of e-mail in relation to 'distance' - the value on the x-axis is the number of hops between the originating and target systems, the y-axis depicts spam score. In the lower part of the diagram regular e-mails are represented in blue, above them UBE are in red.*

Figure 3 illustrates that e-mail messages originating from computers running MS Windows XP are almost exclusively spam (99.3%). There is a sensible explanation for such results: contemporary UBE distribution tools are frequently packaged as viruses or Trojans which infect poorly protected home computers. Regular e-mail dispatched from such systems is distributed through mail-servers maintained by the user's internet service provider (ISP), so it does not compromise the statistics, appearing in our data as originating from other operating systems.

In e-mail originating from MS Windows 2000 the ratio between spam and regular messages is somewhat less extreme. Such OSs are quite frequently used in enterprise applications (hence better protected environments); still, MS Windows 2000 features prominently as a spam source due to the fact that the OS is also quite popular on home computers, where the same considerations apply as in the case of the MS Windows XP above.

E-mail massages originating from computers with Linux or Unix operating systems display a radically different profile: the boundary between spam and regular e-mail is established at 60% and 80% respectively. Linux and Unix operating systems are routinely run on mail servers of ISPs and larger enterprises, with correspondingly better protection. In addition, larger enterprises are especially concerned with the legal implications of UBE originating (or relayed) from their networks. This observable difference contributes a very useful criterion for compiling spam scores of e-mail.

Additional data, derived from the techniques for determining the remote operating system, is the 'network distance' of the originating server. This 'distance' is expressed in the number of hops that an IP packet is subject to along its path through the intermediate network, between the originating and target systems.

The interesting aspect of the above diagram is the relatively obvious boundary between e-mail originating from computers in Slovenia (12 hops or less) – these contain a relatively low portion of UBE – and more distant computers. The majority of unsolicited mail originates from relaying distributors which also tend to be more distant (both in terms of hops and physical distance) – USA, China, Korea - which is illustrated by the wide and intensive red field in the upper right part of the diagram.

# STAFF

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4. Matej Wedam

**Technical and administrative staff**

5. Ivan Ivanjko

# SCIENCE INFORMATION CENTRE SIC

***The Jožef Stefan Institute Science Information Centre is the central Slovene physics library and one of the largest specialist libraries in Slovenia. Our main tasks are the acquisition, archiving, and loan of books and periodicals, and the inputting, updating and control of the institute staff's bibliographic data, as requested by the funding ministry.***

Head:
***Dr. Luka Šušteršič***

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 Slovene library co-operative, COBISS, and use their services to catalogue and loan our materials. You can check what's new in the library, browse our online catalogue, or send inter-library loan requests using our WWW site (http://library.ijs.si/).

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, Stanford HighWire Press, ACS online editions, AIP electronic editions, IoP online journals, Wiley Interscience. We provide access to the Current Contents, INSPEC, Crossfire Beilstein, and Web of Science databases, and the Dialog online database services.

We manage the bibliographic database of the institute's production. The database contains about 70000 records, going back to the institute's inception in 1949. Records of last year's work are included as part of this report.

## STAFF

**Technical officers**

1. Jasna Malalan
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3. Slavka Šmuc, B. Sc.
4. Alenka Štante, B. Sc.
5. Branka Štrancar
6. **Dr. Luka Šušteršič, Head**
7. Saša Žnidar

# ENERGY EFFICIENCY CENTRE

# EEC

***The basic activities of the Energy Efficiency Centre are in efficient energy use, long-term planning in energy, and the reduction of greenhouse-gas 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 activities is thus cooperation with state institutions in the field of efficient energy use, energy planning, environment taxes ($CO_2$ tax) and emission trading; nevertheless, it still remains strongly connected, by its consulting role in energy, with industrial companies and institutions.***

Head:
***Tomaž Fatur, M. Sc.***

**In 2005 the Energy Efficiency Centre (EEC) representative to the Strategic Council for Reforms of the Government of Slovenia coordinated the areas of the Liberalization and Competitiveness of Public Economy Services and managed the energy sector group.**

### Energy and environment

In 2005 the key activities of the Energy Efficiency Centre were centred on various professional tasks in energy and on the reduction of the impact of energy use on the environment, especially in the field of greenhouse-gas emissions. The EEC has long experience in the fields of energy, energy use and electricity production and, in recent years, in the impact of the production and use of energy on the environment. In this area, the EEC prepared, in 2005, various strategic studies for the Ministry of Environment and Spatial Planning and the Ministry of the Economy, necessary for the decisions of both ministries. These studies are from the fields of assessment of the effects of renewable sources on greenhouse-gas emissions, planning of measures for the inclusion of directed electricity consumption, as well as preparation of an energy review for Slovenia for 2004 and 2005.

Research, only symbolically financially supported by the Ministry for Higher Education, Science and Technology, was oriented to the support of professional decisions concerning the impact of energy use on the environment, i.e., more concretely, the implementation of the system of emission trading, which 98 of the largest Slovenian industrial companies and electricity producers entered into on 1 January 2005.

In response to the Operational Programme for the reduction of greenhouse-gas (GHG) emissions, in which the Energy Efficiency Centre has cooperated in recent years, the EEC worked for the Ministry of Environment and Spatial Planning and the Agency for the Environment, in preparing voluntary agreements among the state and industrial companies that want to take advantage of the possibility of reducing their $CO_2$ tax payment. With its knowledge of the industrial sphere, technological procedures and relevant legislation, the centre was able to judge the suitability of individual industrial companies' applications as an authorized state representative. In 2005 the EEC also prepared the Fourth National Communication under the United Nations Framework Convention on Climate Change on visible progress in achieving the obligations of the Kyoto Protocol, which is the cover document of the Slovenian government in the field of greenhouse-gas emissions.

In the annual review of the Slovenian energy sector the EEC drew attention to the fact that all energy use and supply indicators show trends which are essentially worse than political energy expectations. This means that political energy mechanisms have not, until now achieved the expected results. In the future, with active EEC participation, it will be necessary to focus on the execution of the mechanisms for demand-side management to improve competitiveness, reliability and the environment.

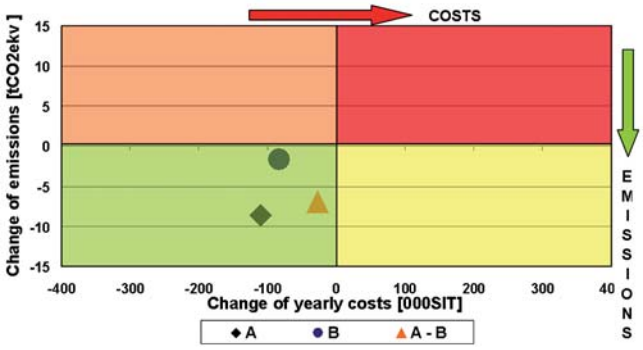


*Figure 1: Evaluation of project costs of GHG emissions reduction with the tool "VEM"*

### Promotion of efficient energy use and energy consulting

In this field, the Energy Efficiency Centre was concerned with cooperation in designing, monitoring and evaluating energy-efficiency programmes, the introduction of energy-efficient technologies and energy management, informing and awareness building of energy consumers and other target groups, as well as the promotion of energy-efficient technologies and procedures.

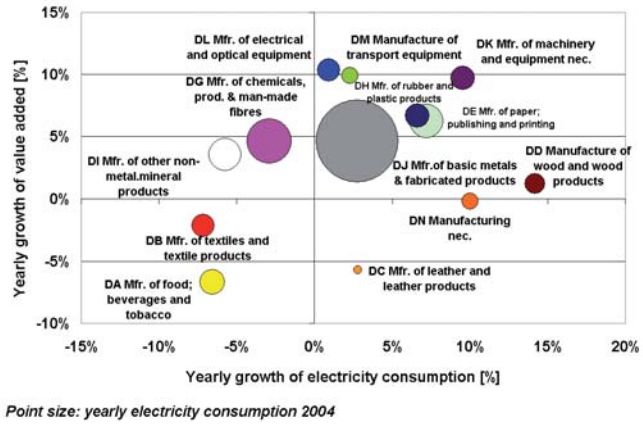


*Figure 2: Yearly growth of electricity consumption*

In the field of cooperation with industrial companies the centre cooperated as a professional consulting institution in purchasing electricity and in the field of advising and preparation of professional documents for cost reductions in several companies.

In 2005 the Energy Efficiency Centre organised seminars and workshops for industrial companies on energy management, energy-efficient technologies and energy planning. The centre also prepared the programme of the largest Slovenian conference of energy managers, "Energy Managers Days", the seventh annual meeting of energy managers; with the participation of more than 200 energy managers it confirmed the quality and public profile of the EEC. The centre issues the Energy Efficiency Newsletter for the Agency for Efficient Use of Energy. Individual EEC experts published numerous articles in magazines and newspapers and took part in radio and television broadcasts.

**International cooperation**

In 2005 the EEC initiated 11 international projects, financed from European Union funds within the Sixth Framework Programme and the European Commission Programme. Four projects in the framework of European Commission programmes 'Intelligent Energy for Europe' (ex SAVE and Altener programme) were successfully concluded.

Projects cover activities in the fields of:

- new technologies and energy efficiency in EU country research programmes: 'Scientific Reference Systems on New Energy Technologies' and 'Energy End-Use Efficiency and Energy RTD' (SRS NET & EEE),
- comparison of energy indicators and energy management in medium and small enterprises: 'Benchmarking and Energy Management Schemes in SMEs',
- compiling and elaboration of current data on renewable energy sources use: 'EurObserv`ER Barometer',
- 1000 small units for the cogeneration of electricity and heat in Europe: 'European Campaign for the Development and Documentation of 1000 Small Scale Cogeneration Projects in European Cities and Towns' (COGEN CHALLENGE),
- Sustainable buildings: 'GreenBuilding',
- Carrying out of the programme MotorChallenge in Slovenia: 'Dissemination, Extension and Application of the Motor Challenge Programme' (DEXA-MCP),
- others.

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 of 11 projects EEC staff took part in numerous foreign professional meetings and visits. For Intelligent Energy for Europe projects, the EEC acquired partial co-financing from the Ministry for Environment and Spatial Planning.

Also in 2005, the EEC was successful in acquiring new international projects within the sixth framework and Intelligent Energy for Europe programmes. These projects will commence in 2006.

## Some outstanding achievements in the past year

1. In 2005 Dr. Miha Tomšič, the EEC representative to the Strategic Council for Reforms of the Slovenian Government, coordinated the areas of the Liberalization and Competitiveness of Public Economy Services and managed the energy sector group.
2. In 2005 the Energy Efficiency Centre made a computer tool *VEM_Kotli* for the evaluation of emissions reduction of small firing and other heating devices in households and other smaller sites, which the Ministry of Environment and Spatial Planning will use for the evaluation of the suitability of financial incentives for energy-efficient investments.
3. The Energy Efficiency Centre has 13 employees and since 1994 participates in various international projects. In 2005 it commenced 11 projects in the framework of European Commission programmes (four within the 6th Framework Programme and seven within the Intelligent Energy for Europe) programme. They are in the fields of energy management, combined production of electricity and heat, sustainable construction, external costs in energy, exploitation of wood biomass, and others.

## Awards and appointments

1. Barbara Petelin Visočnik: TRIMO research award, Trebnje, TRIMO, M. Sc. Thesis 'Introduction of Third Party Financing in Hospitals'

## Organization of conferences, congresses and meetings

1. Energy Days 2005 – 7th Meeting of Slovenian Energy Managers, Portorož, April 2005
2. A Group of Workshops to Help to Prepare Applications to Obtain IPPC Licences, Ljubljana, September, October, November 2005

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### Invited Papers


1. Mihael Gabrijel Tomšič: Obnovljivi viri energije, učinkovita raba energije in operativni program za zmanjšanje emisij toplogrednih plinov. Obnovljivi viri energije: razvojne možnosti, njihov vpliv na okolje in vloga lokalnih skupnosti: javna predstavitev mnenj, Biljana Fon, ed., Ljubljana, Državni zbor Republike Slovenije, 2005, pp. 54-107, 2005.
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### Regular Papers


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2. Tomaž Fatur: Priprava vloge IPPC na področju energetske učinkovitosti. Zbornik, 7. srečanje energetskih menedžerjev Slovenije - Dnevi energetikov 2005, 5. in 6. april 2005, Portorož, Ljubljana, 2005, 13 pp.
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## THESIS

### M. Sc. Thesis


1. Barbara Petelin Visočnik: Introduction of Third Party Financing in Hospitals (Prof. Nevenka Hrovatin)


# INTERNATIONAL PROJECTS

1. Scientific Reference System on New Energy Technologies, Energy End-use Efficiency and Energy RTD
   SRS NET & EEE; 6. FP; 006631
   EC; National Technical University of Athens, Zografou, Greece
   Tomaž Fatur
2. Virtual Balkan Power Centre for Advance of Renewable Energy Sources in Western Balkans
   VBPC-RES; 6. FP; 509205
   EC; University of Ljubljana, Faculty of Electrical Engineering, Ljubljana, Slovenia
   Stane Merše
3. New Energy Externalities Development for Sustainability
   NEEDS; 6. FP; 502687
   EC; Adele Vendetti, Istituto di studi per l'Integrazione dei sistemi, Rome, Italy
   Dr. Mihael Gabrijel Tomšič
4. Integrated European Network for Biomass Co-firing
   NETBIOCOF; 6. FP– EURATOM; 020007
   EC; Maren Watzkat, Verein zur Förderung des Technologietransfers and der Hochschule Bremerhaven E.V., Bremerhaven, Germany
   Dr. Fouad Al-Mansour
5. Strengthening the Knowledge of Local Management Agencies in the Transport Field COMPETENCE
   IEE program
   EIE/04/064/S07.38682
   EC; Odile Kubarth, Forschungsgesellschaft Mobilität - Austrian Mobility Research - Gemeinnüü GmbH (FGM-AMOR), Graz, Austria
   Dr. Fouad Al-Mansour
6. European Campaign for the Development and Documentation of 1000 Small-scale Cogeneration

Projects in European Cities and Towns
COGEN CHALLENGE
IEE program; EIE/22003-138, EIE/04/138/S07.38653
EC; Peter Löffler, The European Association for the Promotion of Cogeneration (COGEN), Brussels, Belgium
Stane Merše

7. Greenbuilding
GREENBUILDING
IEE program; EIE/04/057/S07.38638
EC; Laurenz Hermann, Deutsche Energie-Agentur GmbH, Berlin, Germany
Tomaž Fatur, Marko Pečkaj
8. Benchmarking and Energy Management Schemes in SMEs
BESS; IEE program; EIE/04/246/S07.38678
EC; Roelie Lambrichs-Rozendal, Boudewijn Huenges Wajer, SenterNovem, AA Sittard, The Netherlands
Tomaž Fatur
9. EurObserv ?ER Barometer
EurObserv ?ER
IEE program; EIE/04/014/S07.38552
EC; Diane Lescot, Observ ?ER - Observatoire des Energies Renouvelables, Paris, France
Stane Merše, Polona Lah
10. Dissemination, Extension and Application of the Motor Challenge Programme
DEXA-MCP; IEE program; EIE/04/164/S07.38650
EC; Geraldine Vaidie, Bruno Chretien, Agence de l'environnement et de la maîtrise de l'énergie (ADEME), Angers, France
Tomaž Fatur, Evald Kranjčevič
11. "Bioenergy-Promotion" - Overcoming the Non-technical Barriers of Project-implementation for Bioenergy in Condensed Urban Environments
BioProm; IEE program; EIE/04/100/S07.38585
EC; Holger Haas, Stuttgart Region Economic Development Corporation (WRS), Stuttgart, Germany
Tomaž Fatur, Dr. Fouad Al-Mansour
12. Thematic Network on Combined Heat and Power
CHAPNET; 5. FP; ENK5-CT-2001-20554
Ryszard Krochmalski, Michal Klawe, Energoprojekt-Consulting S.A., Warsaw, Poland
Dr. Mihael Gabrijel Tomšič
13. Regulatory Framework in Completion of the Internal Energy Markets in Slovenia
Subcontracting Agreement
Guus Versmissen, KEMA International B. V., ET Arnhem, Netherlands
Tomaž Fatur

# RESEARCH PROGRAM

1. Environment Impact - Modelling and Assessment
Dr. Mihael Gabrijel Tomšič

# NEW CONTRACTS

1. Bioenergy Promotion
Ministrstvo za okolje in prostor
Dr. Al-Mansour Fouad
2. Fourth National Communication under the United Nations Framework Convention on Climate Change
Ministrstvo za okolje in prostor
Česen Matjaž
3. Bilateral Consultation with IIASA, CLRTAP questionnaires on Strategy and Policy
Ministrstvo za okolje in prostor
Česen Matjaž
4. Editing of Energy Efficiency Newsletter
Ministrstvo za okolje in prostor
Fatur Tomaž, M. Sc.
5. Benchmarking and Energy Management Schemes in SMEs
Ministrstvo za okolje in prostor
Fatur Tomaž, M. Sc.
6. Professional Bases for Starting Points of New Entries to Emission Trading
Ministrstvo za okolje in prostor
Kranjčevič Evald, M. Sc.
7. Dissemination, Extension and Applicationof the Motor Challenge Programme
Ministrstvo za okolje in prostor
Kranjčevič Evald, M. Sc.
8. EurObserv'ER Barometer
Ministrstvo za okolje in prostor
Lah Polona
9. Methodology of Evaluation of Renewables Projects Effects on GHG Emissions
MOPE-Agencija RS za učinkovito rabo energije
Merše Stane, M. Sc.
10. Planning of Inclusion of Demand Side Management in RS
Ministrstvo za gospodarstvo
Merše Stane, M. Sc.
11. Preparation of an Energy Review for 2004
Ministrstvo za gospodarstvo
Merše Stane, M. Sc.
12. European Campaign for the Development and Documentation of 1000 Small-Scale Cogeneration Projects
Ministrstvo za okolje in prostor
Merše Stane, M. Sc.
13. Public Information of the Energy Sector
Ministrstvo za gospodarstvo
Merše Stane, M. Sc.
14. Advising for the Reduction of the Excise Tax for Fuels in Litostroj
Litostroj – Ulitki
Pečkaj Marko
15. Green Building
Ministrstvo za okolje in prostor
Pečkaj Marko
16. Strengthening the Knowledge of Local Management Agencies in the Transport Field
Ministrstvo za okolje in prostor
Pečkaj Marko
17. Advising for the Reduction of the Excise Tax for Fuels in Pomurske mlekarne
Pomurske mlekarne, d. d.
Simončič Milan
18. Reasonableness of Upgrading of the Hydropower Plant Moste
Holding Slovenske elektrarne
Dr. Tomšič Mihael G.
19. Analysis of Potentials and Measures for Cogeneration Promotion
Ministrstvo za gospodarstvo
Urbančič Andreja, M. Sc.
20. Investments in Smaller Power Plants with CHP
Holding Slovenske elektrarne
Dr. Tomšič Mihael G.

# VISITORS FROM ABROAD

1. Ilke Lewington, KEMA, Utrecht, The Netherlands, 27. 1. 2005
2. Ruud Otter, KEMA, Bonn, Germany, 27. 1. 2005
3. Thomas Hamacher, Max-Planck Institute for Plasma Physics, Munich, Germany, 4. 4. 2005
4. Janne Hietamieni, Motiva, Helsinki, Finland, 12.–13. 9. 2005
5. Alan Ryan, Sustainable Energy, Dublin, Ireland, 12.–13. 9. 2005
6. Harris Andreosatos, CRES, Pikermi, Greece, 12.–13. 9. 2005
7. Teun Bolder, SenterNovem, Sittard, The Netherlands, 12.–13. 9. 2005
8. Boudwijn H. Wajer, Senternovem, Sittard, The Netherlands, 12.–13. 9. 2005
9. Kalle Hashmi, STEM, Eskiltuna, Sweden, 12.–13. 9. 2005
10. Hans Even Helgerud, NEPAS, Kjeller, Norway, 12.–13. 9. 2005
11. Jacob Norday, BEKK, Oslo, Norway, 12.–13. 9. 2005
12. Petra Lackner, Austrian Energy Agency, Vienna, Austria, 12.–13. 9. 2005
13. Prof. Dr. Aviel Verbruggen, University of Antwerp, Antwerp, The Netherlands, 14.–15. 11. 2005
14. David Šajna, SIRAM, Milan, Italy, 17. 11. 2005

# STAFF

**Researchers**
1. Dr. Mihael Gabrijel Tomšič
**Postgraduates**
**2. Tomaž Fatur, M. Sc., Head**
3. Evald Kranjčevič, M. Sc.
4. Stane Merše, M. Sc.
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5. Dr. Fouad Al-Mansour
6. Matjaž Česen, B. Sc.
7. Polona Lah, B. c.
8. Marko Pečkaj, B. Sc.
9. Barbara Petelin Visočnik, M. Sc.
10. Andreja Urbančič, M. Sc.
**Technical and administrative staff**
11. Roza Pergarec, B. A.
12. Igor Ribič
13. Milan Simončič

# CENTRE FOR ELECTRON MICROSCOPY CEM

***The Centre for Electron Microscopy (CEM) is a support infrastructure centre containing the electron microscopy equipment necessary for the analytical and research work of the K5, K6, K7 and K9 departments. Other IJS departments, research institutes, universities and industry also have access to the equipment. The CEM equipment users are the materials science researchers involved in chemical and structural analysis of materials on the micro and atomic scales. The major equipment of the CEM are two scanning electron microscopes (JSM-840A and JSM-5800) and two transmission electron microscopes (JEM-2000FX and JEM-2010F).***

Head:
***Asst. Prof. Miran Čeh***

Scanning electron microscopy (SEM) is used for morphological studies of either fractured or polished surfaces. Since both scanning electron microscopes are equipped with X-ray spectroscopy (EDS, WDS), qualitative and quantitative chemical analysis on the micro scale is also possible. Since only a few $\mu m^3$ of the material are non-destructively analyzed, the term electron-probe microanalysis (EPMA) is used for such analytical work.

When the structural features on the nano-scale are to be investigated, however, transmission electron microscopy (TEM) techniques are used. The JEM-2010F in particular is a state-of-the-art TEM/STEM microscope with a FEG (field-emission gun) electron source and is one of best microscopes in Europe. The JEM-2010F point-to-point resolution is below 0.19 nm, which is more than sufficient to observe the atomic columns in crystalline materials. The JEM-2010F is also equipped with an annular dark-field detector (HAADF-STEM) for so-called Z-contrast imaging, which enables the chemical analysis of single atomic columns on the basis of the measured intensities. Both transmission electron microscopes are equipped with analytical systems for chemical analysis (EDS, EELS). The CEM also comprises equipment for SEM and TEM specimen preparation, which is the first step for all electron microscopy observation procedures. Especially important are the high and low-energy ion-millers, which enable the preparation of thin foils, transparent to high-energy electrons.

The analytical work that is performed on the CEM equipment varies, concerning both the investigated materials and/or the electron microscopy techniques used. While the scanning electron microscopy is used mainly for microstructural characterization and chemical analysis of polycrystalline ceramic materials (functional ceramics, engineering ceramics, bio-ceramics, and composites), magnetic materials, glasses, metals, alloys, etc., the transmission electron microscopy is used for structural and chemical investigations of grain boundaries, planar faults, dislocations and

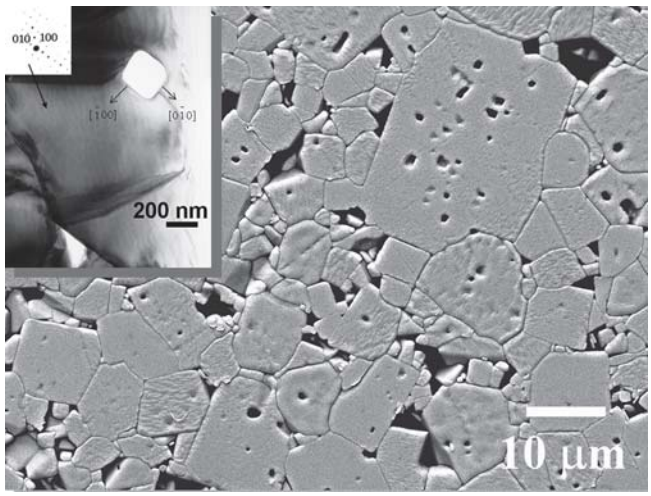


*Figure 1: SEM-BEI micrograph of a thermally etched surface of $K_{0.5}Na_{0.5}NbO_3$ ceramics sintered at 1100°C for 2 and 24 h. The TEM micrograph along the [001] zone axis of a $K_{0.5}Na_{0.5}NbO_3$ grain with a cube-shaped pore, after sintering at 1100°C for 2 h is added. The grain was indexed with a simple perovskite unit cell. Electronic Ceramics: A. Benčan.*

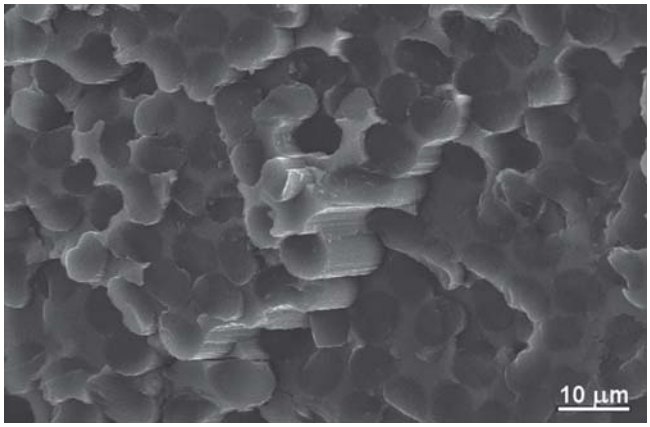


*Figure 2: The morphology of the fracture surface of a carbon-fibre–carbon-matrix composite. Engineering Ceramics: K. Krnel.*

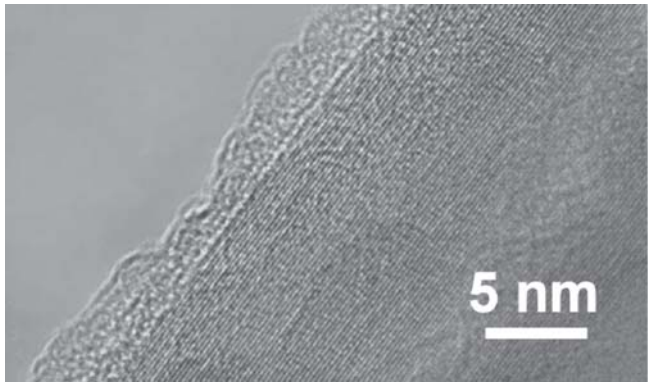


*Figure 3: HRTEM (high-resolution transmission electron microscopy) image of a thin amorphous layer of alumosilicate on a $TiO_2$ rutile particle used as a pigment. Nanostructured Materials: G. Dražić.*


*Figure 4: TEM-BF image of $KNbO_3$ perovskite nano-needle collected along [001] zone axis and the corresponding SAED pattern. Advanced Materials: I. Pribošič, D. Makovec.*

precipitates within the same materials. The analysis of grain boundaries is especially important since it is known that the final physical properties depend to a large extent on the structure and chemistry of the 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 on the main tasks is to maximise the microscopes operational time. This complex and expensive equipment needs regular daily maintenance apart from servicing. Other activities of the CEM are the organisation of training courses for operators and the implementation of new analytical methods, which are realized with the help of CEM co-workers.

# 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 direct exchange of information and experience between researchers and the users of their research results.***

Head:
***Mitja Jermol, M. Sc.***

By partnering and active engagement in different European research projects the Centre successfully extended 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 such as networked and virtual organizations. The Centre is currently active in four European projects: The ECOLEAD Integrated project (European Collaborative Networked Organisation Leadership Initiative), the SEKT Integrated project (Semantically Enabled Knowledge Technologies), the PASCAL Network of Excellence (Pattern Analysis, Statistical Modelling and Computational Learning), and IST WORLD (Knowledge Base for RTD Competencies)

In the year 2005 we have also collaborated with different European partners in several project proposal preparations. Two of them (Extended Enterprise management in Enlarged Europe –E4, and Open Source Enterprise Resource Planning and Order Management System for Eastern European Tool and Die Making Workshops - Tool EAST) were successfully evaluated and will begin in January 2006.

We develop and prepare carefully designed educational events, such as seminars, workshops, conferences 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, ecology, medicine, business decisions, finance, marketing, automation and process control. Special consideration is given to the managers and decision makers who are aware of the strengths and benefits for the success of their business.

**Our goal is to become an important player in knowledge transfer and the promotion of natural, technical and engineering sciences in local communities, Europe, and world wide. By combining up-to date knowledge with various research and development achievements in various areas, connecting with other centres of excellence around the world, and using different methods and technologies in knowledge transfer, we wish to build a Virtual Learning Community and thus contribute to an innovative society through supporting more efficient knowledge and ideas transfer between research and industry.**

All educational events are designed to transfer basic, additional, and the latest expert knowledge to the companies and the 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 have prepared a number of training web portals with more than 500 hours of recorded tutorials from different domains of knowledge available at:
http://solomon.ijs.si/, http://seminars.ijs.si/ecolead/,
http://seminars.ijs.si/pascal/, http://seminars.ijs.si/sekt/,
http://seminars.ijs.si/mps.

In the year 2005 we have prepared three seminars with approx. 60 participants from Slovenia, four workshops sponsored by different EU projects with approx. 200 participants from Slovenia and abroad, and the ACAI (Advanced Course on Artificial Intelligence) Summer School which took place in June and July 2005 and had 100 participants from all over the world.

We have successfully applied for the next PASCAL Summer School on Knowledge Technologies which will take place in September 2006.

Because of the nature of our activities we are also very much involved in the activities of Jožef Stefan International postgraduate school.

Because of our experience in European projects we have decided to offer our services to industry and other organizations for consulting, pre-evaluating and helping to prepare EU project proposals, as well as support for project implementation. We have brought together a number of young experts with concrete ideas, experts from the institute with experience in writing project proposals, EU project coordination and operation, and evaluators of project proposals for the European Commission.

## Organization of conferences, congresses and meetings

1. Production management and information systems, Ljubljana, 31 January -4 February 2005

2. Subspace, Latent Structure and Feature selection techniques: Statistical and Optimisation perspectives, Bohinj, 25-27 February, 2005
3. Workshop for potential evaluators, Ljubljana, 23 March, 2005
4. Automation and information projects, Ljubljana, 18-22 April 2005
5. ACAI'05 'Advanced Course on Knowledge Discovery & First SEKT Summer School on Semantic Web', Ljubljana, 27 June-8 July, 2005
6. Building blocks for computer automation, Ljubljana, 17-21 October 2005
7. ECOLEAD-First Industry Training-Business Workshop, Nova Gorica, 6-7 October 2005
8. Complex Objects Visualization Workshop, Koper, 16-19 November, 2005

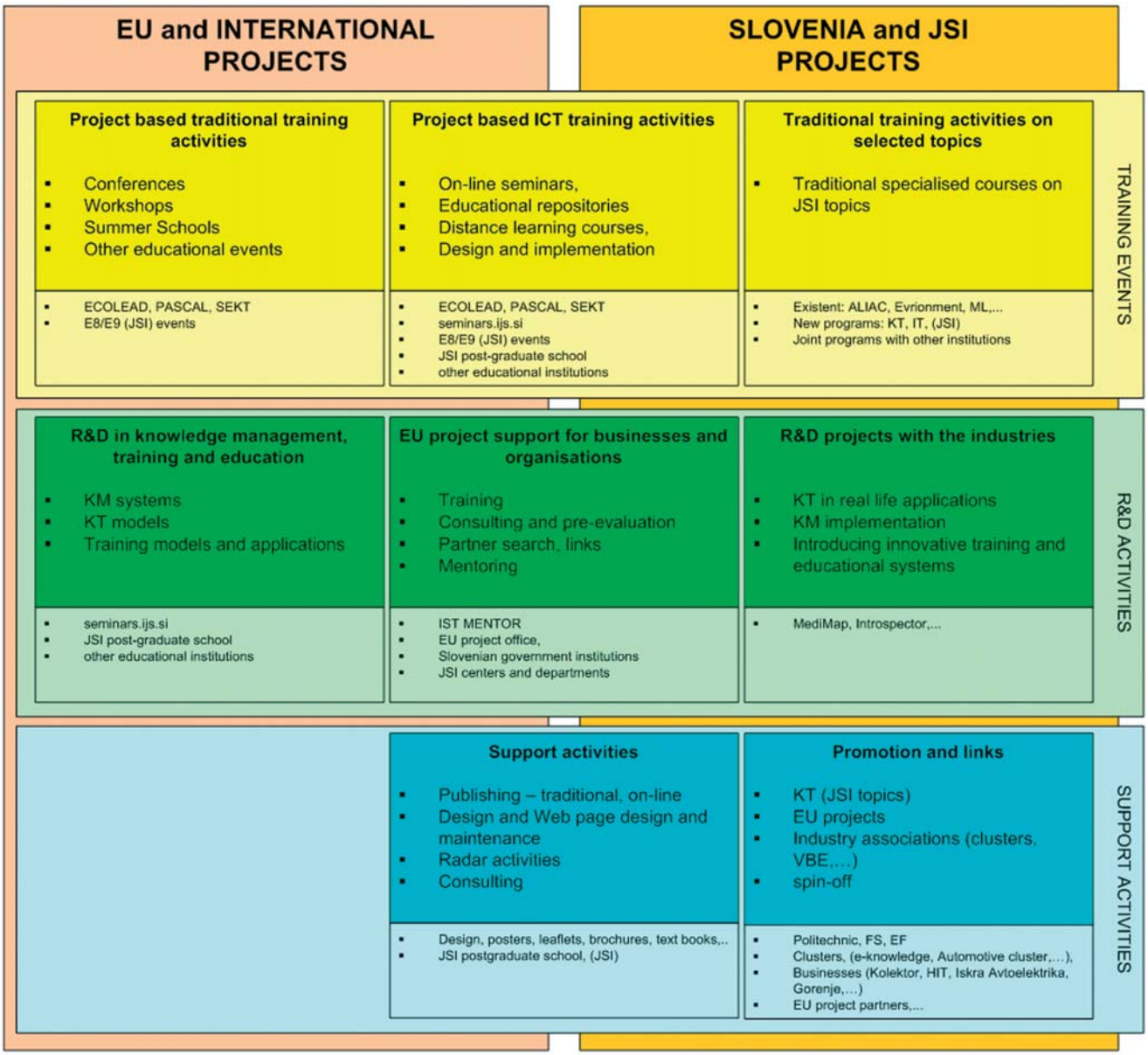


*Figure 1: Activities of the Centre*

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## REVIEW ARTICLES AND CHAPTERS IN BOOKS

1. Gregor Erbach, Marko Grobelnik, Mitja Jermol, Brigitte Jörg, Hans Uszkoreit: Network approaches to current research information systems. Innovation and knowledge economy: issues, applications, case studies(Information and communication technologies and the knowledge economy), Paul Cunningham, ed., Miriam Cunningham, ed., Amsterdam [etc.], IOS Press, 2005, pp. 1235-1242.

## PUBLISHED CONFERENCE PAPERS

### Regular Papers

1. Mitja Jermol, Nada Lavrač: Virtual learning community: a facilirator of knowledge transfer in collaborative networked organizations. Common innovation in e-learning, machine learning and humanoid approaches: Human system learning, who is in control?: proceedings of the Fifth International Conference on Human System Learning (ICHSL.5) = actes du cinquieme Colloque International sur l'Apprentissage Personne Systeme (CAPS.5): 22-25 November 2005, Marrakech, Morocco, Paris, Europia, 2005, pp. 11-20.
2. Nada Lavrač, Marko Bohanec, Aleksander Pur, Bojan Cestnik, Mitja Jermol, Tanja Urbančič, Marko Debeljak, Branko Kavšek, Tadeja Kopač: Resource modeling and analysis of regional public health care data by means of knowledge technologies. Artificial intelligence in medicine: proceedings(Lecture notes in computer science, Lecture notes in artifical intelligence, 3581), 10th Conference on Artificial Intelligence in Medicine, AIME 2005, Aberdeen, UK, July 23-27, 2005, Silvia Miksch, ed., Jim Hunter, ed., Elpida Keravnou, ed., Berlin, Heidelberg, New York, Springer, cop. 2005, pp. 414-418.
3. Nada Lavrač, Peter Ljubič, Mitja Jermol, Gregor Papa: A decision support approach to modeling trust in networked organizations. Innovations in applied artificial intelligence: 18th International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, IEA/AIE 2005, Bari, Italy, June 22-24,2005: proceedings(Lecture notes in computer science, Lecture notes in artificial intelligence, 3533), Moonis Ali, ed., Floriana Esposito, ed., Berlin, Heidelberg, Springer, 2005, pp. 746-748.
4. Peter Ljubič, Nada Lavrač, Joël Plisson, Dunja Mladenić, Stefan Bollhalter, Mitja Jermol: Automated structuring of company competencies in virtual organizations. Zbornik 8. mednarodne multikonference Informacijska družba IS 2005, 11. –17. October 2005 (Informacijska družba), Olga Markič, ed., Matjaž Gams, ed., Urban Kordež, ed., Marjan Heričko, ed., Dunja Mladenić, ed., Marko Grobelnik, ed., Ivan Rozman, ed., Vladislav Rajkovič, ed., Tanja Urbančič, ed., Mojca Bernik, ed., Marko Bohanec, ed., Ljubljana, Institut "Jožef Stefan", 2005, pp. 190-193.

## INTERNATIONAL PROJECTS

1. Knowledge Base for RTD Competencies
   IST-WORLD; 6. FP; 015823
   EC; Leonie Schaefer, Michael Ziegler, Deutsches Forschungszentrum für Künstliche Intelligenz GmbH, Kaiserslautern, Germany
   Mitja Jermol, Marko Grobelnik
2. Central European Centre for Women and Youth in Science
   CEC-WYS; 6. FP; SAS6-CT-2004-003582
   EC; Dr. Marcela Linková, Institute of Sociology, Academy of Sciences of the Czech Republic, Prague, Czech Republic
   Mitja Jermol, Asst. Prof. Dunja Mladenič
3. Semantically-Enable Knowledge Technologies
   SEKT; 6. FP; 506826
   EC; John Davis, British Telecommunications plc, London, Great Britain
   Mitja Jermol, Asst. Prof. Dunja Mladenič, Marko Grobelnik
4. European Collaborative networked Organizations LEADership initiative
   ECOLEAD; 6. FP; 506958
   EC; Martin Ollus, Technical Research Centre of Finland, Espoo, Finland
   Mitja Jermol, Prof. Nada Lavrač
5. Pattern Analysis, Statistical Modelling and Computational Learning
   PASCAL; 6. FP; 506778
   EC; Eileen Simon, The University of Southampton, School of Electronics and Computer Science, Highfield, Southhampton, Great Britain
   Mitja Jermol, Asst. Prof. Dunja Mladenič

## VISITORS FROM ABROAD

1. Michael Witbrock, CYCORP, Austin, ZDA, 3-8 July 2005
2. Roberto Santoro, ESOCENET, Rimini, Italy, 8-9 November 2005
3. Leandro Loss, Universidade Federal de Santa Catarina, Brazil, 9 June 2005-January 2006

## STAFF

**Postgraduates**

1. Jure Ferlež, B. Sc.
2. **Mitja Jermol, M. Sc., Head**

**Technical officers**

3. Marjana Plukavec***, B. Sc.
4. Špela Sitar, B. Sc.

**Technical and administrative staff**

5. Tina Anžič
6. Sebastjan Mislej

*** Employed by Junior Achievement

# MILAN ČOPIČ NUCLEAR TRAINING CENTRE ICJT

***The mission of our training centre is training in the field of nuclear technologies and radioactivity. In addition, we are actively informing the public about those technologies. Activities of the Nuclear Training Centre in the year 2005 can be divided into four areas: training in the area of nuclear technologies, radiological protection training, organization of international training courses, and public information.***

Head:
***Prof. Igor Jenčič***

**Training in the area of nuclear technologies** is our primary mission. Because this year there was no initial training course for the control room operators of NPP Krško, we have continued a thorough revision of the learning objectives and training materials for this course. Furthermore, we have revised the materials for the 'Basics of nuclear technology: Systems' course. A 'Basics of nuclear technology' course was held for the non-control room personnel of Krško NPP and for the staff of some other organisations. We have also prepared two courses for the Slovenian Nuclear Safety Administration (Advanced training using simulators on safety related NPP Krško systems, and Training of Expert Groups for Emergency Response).

There were 16 **radiological protection training** courses for medical, industrial and research use of radioactive sources. In addition, there were two courses for officers of Slovenian Army.

We have had 6 **international courses**. The most important was the 3-week course 'Current Issues in Research and Power Reactors' which was intended for developing countries and where we have contributed more than half of the lecturers. Four workshops were held under auspices of the International Atomic Energy Agency (IAEA), and one course in collaboration with the European Commission, i.e., the Institute for Transuranium Elements, Karlsruhe.

We have organized an international conference of nuclear lawyers, 'Nuclear Inter Jura', in Portorož, which was attended by 123 participants. In collaboration with the Department for Environmental Sciences we organized the international conference '10th International Symposium on the Interactions Between Sediments and Water' in Bled, with 155 participants.

In the area of **public information** we have continued with educational programs for elementary and high school pupils. Groups of children and other visitors come to listen to lectures about nuclear technology, or about radioactive waste, and to visit our exhibition. This year we had 174 groups with 8646 visitors. Since 1993 our information centre has been visited by 89171 pupils, teachers and other visitors altogether. For public information purposes we have also prepared mockups of fuel pellets and a new 64-page, bilingual publication Mini Encyclopaedia of Nuclear Energy. The permanent exhibition was thoroughly renewed and expanded with a new section 'Fusion – Energy of Future'.

We have also collaborated with the Krško NPP in the preparation, design, and translation of their Annual Report for 2004.

**In the year 2005 the permanent exhibition on nuclear energy was thoroughly renewed and expanded with a new section Fusion – Energy of Future.**

*Figure 1: Lecture room P1 has been equipped for courses using computers. The first such course was Nuclides.net.*

## Table of training activities at Nuclear Training Centre in 2005

| Date | Title | Partici-pants | Lecturers | Weeks | Participant x weeks |
|---|---|---|---|---|---|
| 10. 2. | Radiation protection for industrial and other practices (sealed sources), Refresher Course | 2 | 2 | 0.2 | 0.4 |
| 10. 2. | Radiation protection for industrial and other practices (unsealed sources, Class III), Refresher Course | 1 | 2 | 0.2 | 0.2 |
| 28. 2. - 4. 3. | IAEA Workshop on Best Estimate and Uncertainty Analyses | 22 | 5 | 1.0 | 22.0 |
| 17. 3. | Radiation protection for officers of Slovenian Army – dosimetric quantities and practical work with radiation detectors | 7 | 4 | 0.2 | 1.4 |
| 23. 3. - 12. 5. | Radiation protection for medical and veterinary workers - diagnostic radiology | 50 | 5 | 0.6 | 30.0 |
| 9. - 13. 5. | IAEA Workshop on Safety Analyses in Support of Event Evaluation | 18 | 4 | 1.0 | 18.0 |
| 23. 5. - 24. 6. | SNSA advanced training, using simulators, on safety related NPP Krško systems | 6 | 4 | 2.0 | 12.0 |
| 30. 5. - 24. 6. | Basics of nuclear technology, theory | 5 | 8 | 4.0 | 20.0 |
| 13. - 15. 6. | IAEA Workshop on The Role of Instrumentation and Control in Power Uprating Projects in Nuclear Power Plants | 12 | 2 | 0.6 | 7.2 |
| 14. 6. | Radiation protection for industrial and other practices (sealed sources) - Refresher Course | 6 | 4 | 0.2 | 1.2 |
| 14. 6. | Radiation protection for industrial and other practices (unsealed sources) - Refresher Course | 6 | 5 | 0.2 | 1.2 |
| 20. 6. - 8. 7. | Current Issues in Research and Power Reactors | 38 | 17 | 3.0 | 114.0 |
| 30. 6. | Refresher course for NEK subcontractor managers | 8 | 4 | 0.2 | 1.6 |
| 6. 7. | Radiation protection for workers of Salonit Anhovo | 8 | 1 | 0.2 | 1.6 |
| 29. 8. - 23. 9. | Basics of nuclear technology: systems | 12 | 8 | 4.0 | 48.0 |
| 14. - 16. 9. | Radioactivity, Radionuclides & Radiation, A multimedia training course with Nuclides.net | 44 | 14 | 0.6 | 26.4 |
| 29. 9. | Radiation Protection for Nuclear Medicine Dept. (General Hospital Maribor) - Refresher Course | 14 | 4 | 0.2 | 2.8 |
| 3. - 7. 10. | IAEA Regional Workshop on Operational Experience Feedback | 18 | 4 | 1.0 | 18.0 |
| 6. 10. | Radiation protection for industrial and other practices (sealed sources) - Refresher Course | 10 | 3 | 0.2 | 2.0 |
| 6. 10. | Radiation protection for industrial and other practices (unsealed sources) - Refresher Course | 15 | 4 | 0.2 | 3.0 |
| 13. – 14. 10. | Training of officers of Slovenian Army – the effects of Nuclear weapons | 7 | 6 | 0.4 | 2.8 |
| 29. 11. | Radiation protection for Nuclear Medicine Dept. (KNM KCLJ) - Refresher Course | 50 | 6 | 0.2 | 10.0 |
| 5.-7. 12. | Radiation protection for industrial and other practices (unsealed sources) | 11 | 5 | 0.6 | 6.6 |
| 5. - 7. 12. | Radiation protection for industrial and other practices (sealed sources) | 10 | 4 | 0.6 | 6.0 |
| 5. - 8. 12. | Radiation protection for medical and veterinary workers | 12 | 9 | 1.0 | 12.0 |
| 8. 12. | Radiation protection for industrial and other practices (radiography) - refresher | 13 | 4 | 0.2 | 2.6 |
| 13. 12. | Training extension for radiation protection officers | 6 | 2 | 0.1 | 0.6 |
| **TOTAL** | | **411** | **140** | **22.9** | **371.6** |

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### Regular Papers


1. Bruno Cvikl, Dean Korošak, Matjaž Koželj: C-U investigation for fermi level alignment at metal/organic semiconductor junction. Proceedings, 41th International Conference on Microelectronics, Devices and Materials and the Workshop on Green electronics, September, 14. - September 16. 2005, Ribno, Slovenia, Barbara Malič, ed., Darko Belavič, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2005, pp. 333-338.
2. Radko Istenič, Igor Jenčič: Youngsters about nuclear energy: Year 2004 poll. Transactions, 17th International Meeting of Nuclear Communicators, PIME 2005, 13-16 February 2005, Paris, Paris, European Nuclear Society, 2005, pp. 101-103.
3. Dean Korošak, Bruno Cvikl, Matjaž Koželj: Spin injection at metal/organic semiconductor interface. Proceedings, 41th International Conference on Microelectronics, Devices and Materials and the Workshop on Green electronics, September, 14. - September 16. 2005, Ribno, Slovenia, Barbara Malič, ed., Darko Belavič, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2005, pp. 339-343.
4. Matjaž Koželj, Bruno Cvikl, Dean Korošak: Investigation of bilayer, ionized cluster beam deposited AL/PTCDA/ITO organic semiconductor structure bz the C-U and I-U methods. Proceedings, 41th International Conference on Microelectronics, Devices and Materials and the Workshop on Green electronics, September, 14. - September 16. 2005, Ribno, Slovenia, Barbara Malič, ed., Darko Belavič, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, 2005, str, 327-332, 2005.
5. Joseph Magill, D. J. Hamilton, M. Betti, L. Aldave de las Heras, G. Tamborini, K. Mayer, S. Abousahl, O. Cromboom, Tomaž Žagar, Igor Jenčič, G. Caratti: Education and training courses on nuclear science, illicit trafficking, and environmental radioactivity - a JCR activity in Eu enlargement and integration. Proceedings, 3rd International Conference on Education and Training in Radiological Protection, 23-25 November 2005, Brussels, Brussels, ENS, 2005, pp. 1-5.


## INTERNATIONAL PROJECTS

1. Nuclear European Platform of Training and University Organisations
   NEPTUNO; 6. FP, EURATOM; FI60-CT-2003-508849
   EC; CEA/SACLAY, INSTN / UERTI, Gif-sur-Yvette Cedex, France
   Prof. Igor Jenčič, Prof. Leon Cizelj
2. IAEA Regional Workshop on Deterministic Best Estimate Analyses Including Uncertainties
   IABEUA; RER/9/083
   Milorad Dušič, IAEA, Vienna, Austrija
   Marjan Tkavc
3. IAEA Regional Workshop on Safety Analyses in Support of Event Evaluation
   IASA; RER/9/083
   Milorad Dušič, IAEA, Vienna, Austria
   Tomaž Skobe
4. IAEA Regional Workshop on Role of Instrumentation and Control Syytems in Power Uprating in Nuclear Power Plants
   IAICUPRATE; RER/4/025
   Oszvald Glocker, IAEA, Vienna, Austria
   Radko Istenič
5. Workshop Current Issues in Research and Power Reactors
   NEWREACT05
   Andrew Kadak, Kadak Associates Inc., Barrington, Rhode Island, USA
   Tomaž Skobe
6. 6th Radioactivity, Radionuclides & Radiation Multi-Media Training Course
   NUCLIDES05; ITU.B202245
   Joseph Magill, EC, Joint Research Centre, Institute for Transuranium Elements, Eggenstein-Leopoldshafen, Germany
   Matjaž Koželj
7. IAEA Regional Workshop on Operating Experience Feedback
   IAOEF; RER/9/84
   Rejane Spiegelberg Planer, IAEA, Vienna, Austria
   Radko Istenič

## NEW CONTRACTS

1. Professional Training 2005
   Nuklearna elektrarna Krško
   Dr. Igor Jenčič
2. Information Centre 2005
   Agencija za radioaktivne odpadke
   Dr. Igor Jenčič
3. Additional training of SNSA personnel
   Ministrstvo za okolje in prostor
   Dr. Igor Jenčič

## STAFF

**Researchers**

**1. Prof. Igor Jenčič**, Head**

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12. Egon Srebotnjak, M. Sc.
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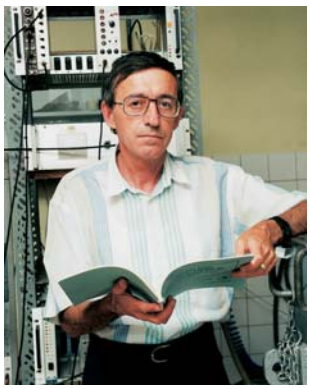
# RADIATION PROTECTION UNIT

# SVPIS



Head:
***Bogdan Pucelj, M. Sc.***

***The main tasks of the Radiation Protection Service are to carry out personal dosimetry and to monitor the working areas and the general environment of the Reactor Centre.***

In 2005 134 radiation workers were monitored using thermo-luminescent dosimeters (TLDs). Most doses were at the level of natural background. The highest annual dose recorded was 0.43 mSv, a value much below the annual limit for radiation workers (20 mSv per year).
Additional TLDs were used to monitor external radiation exposure at different locations of the Reactor Centre. Only background levels were recorded.

The environmental impact of activities within the Reactor Centre was estimated by evaluating source term monitoring. The dose to the population due to atmospheric and liquid discharges was estimated to be much lower than one micro-Sievert per year, which is only one thousandth of the annual limit for the population.

## NEW CONTRACT

1. Assessment of radiation exposure during airflights
   Ministrstvo za zdravje
   Bogdan Pucelj, M. Sc.

## STAFF

**Postgraduate**
1. Matjaž Stepišnik, B. Sc.

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4. Dr. Matjaž Štuhec

**Technical and administrative staff**
5. **Bogdan Pucelj, M. Sc., Head**

# TECHNOLOGY TRANSFER OFFICE U-9

***The main fields of activity:***

- ***Knowledge and technology transfer from the JSI to the Slovenian and European industrial spheres,***
- ***Technology transfer from Europe***
- ***Research and applied project management***
- ***Assistance in the JSI patents application assessment procedures***
- ***Support for the commercialisation of JSI patents.***

Head:
***Prof. Peter Stegnar***

**Innovation and promotion of competitiveness through the linking of people, knowledge and technologies.**

The main activity of the Technology Transfer Office is the operation of the Innovation Relay Centre - IRC Slovenia (www.irc.si). The IRC Slovenia team has, in 2005, continued its activities in Slovenian companies, research institutions and other areas, to accelerate transnational technology co-operation. IRC Slovenia staff visited over 110 companies and other organizations. In those organizations over 20 technology offers and requests (Goodyear d. o. o., Ham d. o. o., Bia Separations d. o. o., CEE d. o. o., Alpina d. d., Ameba+ d. o. o., Hobotnica d. o. o., Lindap d. o. o., TCG UNITECH Lth-ol d. o. o., Laboratory of Telecommunications at the Faculty of Electrical Engineering, University of Ljubljana, Nanokem d. o. o., Potom d. o. o., Optotek d. o. o. and others) were identified and promoted in the IRC network. We received over 50 responses from abroad. Companies and organizations from our database were regularly informed about new technologies identified by IRC Network experts. We received over 190 expressions of interests from Slovenian companies and other organizations. This lead to 23 negotiations. **Together with our partner from Maribor we assisted in 7 international agreements for technical co-operation** (Hidroinženiring d. o. o., Alupak d. o. o., Eurocontor s. p., Optotek d. o. o., MBS d. o. o., Strip's d. o. o. in Ameba+ d. o. o.). The seminar 'Financing innovative companies' was organised in March 2005. In the same month a company mission to Linz was organised in co-operation with the Automotive Cluster of Slovenia and the Slovenian Plasttechnics Cluster. We were active within the Slovene Environmental Cluster as promoters of the members and their technologies in Europe. We agreed to prepare two Technology Watch Reports. A Technology Watch Report on Recycling of Waste Solvents was prepared for the company Kemis d. o. o.

**NPDnet**

The second largest activity of the Technology Transfer Office is the New Product Development - NPD-Net project, which is an INTERREG III C project. The main coordinator is from Greece (http://npd-net.urenio.org). The aims of the project, which involves partners from Greece, the Basque region, Wales, Estonia, Romania and Slovenia, are to establish a network of virtual centers for the development of new products according to a common methodology, which will be available on the web in the form of manuals and checklists in the languages of all participants, and the training of local consultants and the introduction of the NPD methodology in local small and medium enterprises. For this project we have succeeded in obtaining 25% co-financing from the National Agency for Regional Development.

**Boost IT**

The BOOST-IT project aims to improve the levels of innovation and technological cooperation in Europe -and in particular in the Southern Countries, New Member States and Candidate and Associate countries, where such levels are lower – by implementing a range of technological services targeted to the driving force behind European economic recovery and growth i.e. high tech SMEs and spin-offs from the IT sector hosted in small scale incubators. The main Slovenian partners are Tehnološki Park Ljubljana and Tehnološki Park Primorska, JSI.

Other participants are: Portugal - IPN, Sogist; Israel - JVP, Matimop; Poland – FUL; Ukraine – CKT; Croatia – EIL.

**TINIS**

The principal aim of the TINIS project is to improve regional development with initiatives to increase the number of innovations in the field of Information Communications Technologies (ICT) and to direct local political measures towards the same goal.

Secondary results are:
- to improve existing methods and develop new ones
- to enable all TINIS members easy access to new methods
- to improve ICT networking in regions participating in the TINIS project
- to re-establish sustainable connections between partners in project and regions
- to develop a professional ICT network in all participating regions

The TINIS project was graded second best of 50 registered projects.

Comparative studies of national measures targeting improvement of innovation practices in partner states were made in 2005 - catalogue 1. In catalogue 2, methods used in daily work are shown. We held the Kick-off meeting and two workshops, in Czech Republic and Luxembourg.

The Technology Transfer Office also applied for other EC funded projects and succeeded with the TINIS project, lead by partners from the Valone region. (The Faculty of Electric Engineering of Ljubljana is also involved.) The aim of this project is to enhance the connections among ICT clusters.

### The most important achievement

The activities in progress under the "NPD-net" project have had a very positive response within Slovenian companies. The workshop with the title "New Product Design" received more registrations than we could accept, despite raising the initial quota by 100%. We believe that we will also have a very positive response for the "Final Conference" and NPD Guide.

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1. Innovation Relay Centre of Slovenia
   Si-IRC-04-08; 6. FP; 510419
   EC
   Miroslav Gregorič, Prof. Peter Stegnar
2. Innovation and New Product Development based on Inter-Region Networks
   NPD-NET
   INTERREG IIIC Operation
   EC; Dr. Dimitris Milossis, Urban and Regional Innovation Research Unit (URENIO), Aristotle University of Thessaloniki, Thessaloniki, Greece
   Miroslav Gregorič, Dr. Žiga Bolta
3. Technological Innovation Network in the Field of Information Systems
   TINIS
   INTERREG IIIC, West Zone
   EC; Veronique Pirot, INFOPOLE Information Systems, Namur, Belgium
   Andrej Gyergyek
4. Environmental Security Issues Arising from the Legacy of Uranium Extraction in the Central Asia Republics KZ, KY, TJ and UZB
   NATO SfP – 981742
   NATO Public Diplomacy Division, North Atlantic Treaty Organisation, Brussels, Belgium
   Prof. Peter Stegnar
5. Uranium Extraction and Environmental Security in the Central Asian Republics
   NATO SfP - Uranium Extraction Legacy
   ESP.EAP.SFPP 981742
   NATO Public Diplomacy Division, North Atlantic Treaty Organisation, Brussels, Belgium
   Prof. Peter Stegnar
6. Leasing of Hot Cell Facility within the Framework of the Phare Project
   JSI/IRE
   Henri Bonet, L'Institut National Des Radioéléments (IRE), A Belgian Public Utility Fondation, Fleurus, Belgium
   Prof. Peter Stegnar

## NEW CONTRACTS

1. Funding of NPD-net project in the framework of Interreg III C
   Agencija RS za regionalni razvoj
   Dr. Žiga Bolta, Dr. Anton Ružič

## VISITORS FROM ABROAD

1. Gabriele Gatti, IRC Irene Trieste, Consorzio per l'AREA di Ricerca - AREA Science Park, Trieste, Italy, 4. 2. 2005
2. Hans Jürgen Flor, Sverre K. Nilsen, Bjřrn Lukkedal, SINTEF/IRC Norway, Trondheim, Norway, 21. 4. 2005 – 22. 4. 2005
3. Daniel Escacena Ortega, IRC Valencia, Valencia, Spain, 21. 4. 2005 – 22. 4. 2005
4. José Aravena, IRC Chile, Santiago, Chile, 29. 4. 2005
5. Renate Weissenhorn, European Commission, DG Enterprise and Industry D2, Support to Innovation, Brussels, Belgium, 7. 6. 2005
6. Hans Jürgen Flor, SINTEF/IRC Norway, Trondheim, Norway, 27. 9. 2005
7. Adrien Fuzesi, Budapest University of Technology and Economics, IRC Hungary, Budapest, Hungary, 18. 10. 2005 – 21. 10. 2005

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7. **Prof. Peter Stegnar**, Head**
8. Špela Stres, B. Sc.
9. Sonja Živkovič