center for technology transfer and innovation
at the Jožef Stefan Institute

Institut "Jožef Stefan", Ljubljana, Slovenija

Opportunities for collaboration

with the Jožef Stefan Institute


Institut "Jožef Stefan"

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// Foreword

We live in crucial times.

Less money is being spent on research, year by year.

We are relying on the (not so far ago) non-existent financial resources to survive and yet we try to maintain the level of research, with which we express respect to the mighty names of Slovenian science, who for centuries and decades have co-created the history of our Institute.

We are strong and fearless, because we believe that science is the tip of an arrow that flies through time into the future and only by trusting its course we can move forward in the step that is indispensable, even though infinitely difficult.

We live in historic spaces.

Improving collaboration between public research organisations (PROs) and the economy is a political guideline, but we are on the side of professionalisation.

We strive to open a gap in space and to light it up so that in its translucency it would become bright from the fragments of opportunity, reflected in gentle pieces of existence – between them and us. We are nonexistent.

We are the ones interlacing filaments, strings between brothers, between sisters, between a brother and a sister who have lost connection and perception of one another through decades of their own excellence. Perfect individually, but inadequate together in their inability to reach out for each other for no reason but for the fragments of stardust shimmering in the air. Incapable to reach out for the opportunities which the space has created with them and for them – but with them, cold and divided, looking through, into the void. We are nonexistent.

We are serfs for sparks through which the newly open and illuminated space and time is altered into a lapse without gravity, into a stretch of revealed opportunities, unison and alliance. We are non-existent.

And still… this is us and this is one of the sparks.

On behalf of the Centre for Technology Transfer and Innovation and in its name,
Špela Stres

// Instructions for use

This brochure entitled Opportunities for Collaboration with the Jožef Stefan Institute presents all 27 research departments of the Institute in four main categories: Physics (F); Chemistry, biochemistry, materials and environment (B, K and O); Electronics and information technologies (E) and Nuclear engineering and energy (R).

A brief summary of activities is given for each department including a short description of its activities compatible with specific industries and the applicative offer of its services.

For simplicity and categorisation, past business and industry collaboration models are also stated for the majority of departments.

Due to extensiveness and segmentation as well, a number is given for each previous case of collaboration with the industry (e.g.: I/2.) which represents the classification according to strategic research and innovation partnerships (SRIP). The main three categories of SRIPs (I. Digital, II. Circular, III. (S)Industry4.0) are also presented in different colours for better visualisation. The key of SRIPs is included before the representation of departments and after their description with the Index of SRIPs comprising all past cases of business collaboration.

We hope and wish that this short but nevertheless substantial brochure in terms of content and expertise will contribute to collaboration and operation for the benefit of Slovenian society.

If you are interested in collaboration, please write to tehnologije@ijs.si to be connected with a person responsible for the respective department.

// The Jožef Stefan Institute

The Jožef Stefan Institute was established in 1949 and today employs over 950 people which makes it the largest institute in this part of Europe. Its mission is to generate, disseminate and transfer knowledge in the field of natural sciences, engineering and life sciences.

The Institute conducts top-class research and develops technologies in various fields, such as nanotechnology, new materials, biotechnology, management and production, communication, computer science and knowledge, environment and reactor technology.

The research units of the Institute are departments and laboratories. The research activity of the Institute is conducted in 28 departments and is defined as a long-term orientation of the Institute according to the selected research domains. Its work is financed through projects for which the Institute is applies on domestic and foreign markets in the public and private sectors. In terms of their number and size, the majority of projects is financed by the Slovenian Research Agency, while some are also funded by the Ministry of Education, Science, Culture and Sport. In particular, these include research programmes, basic and applicative projects, postdoctoral projects and projects of young researchers. A significant part of research is also financed from European funds and the private sector.

// Centre for Technology Transfer and Innovation

The Centre for Technology Transfer and Innovation has been operating as a financially independent internal unit of the Jožef Stefan Institute since 1 January 2011. Our primary task is to transfer technologies and innovations from the Jožef Stefan Institute, the most successful Slovenian research organisation, into the private sector, i.e. by embarking on new collaborative projects with industry and establishing new spin-offs, preparing market analysis, assisting in intellectual property protection and its marketing.

We assist individuals in acquiring rights derived from intellectual property, and signing contracts with industry, establishing spin-offs and helping them in market penetration, and provide advice and assistance in drawing up project applications and designing business plans. We offer specific advice to optimise intellectual property protection and carry out active marketing in the respective field, provide professional legal advice, in particular in the field of intellectual property and possibilities of exploiting intellectual property rights (technology and market assessments), and look for suitable partners to sell intellectual property, conduct negotiations, and also draw up appropriate contracts for licensing or sale of intellectual property.

// Examples of business collaboration / Key

Examples of business collaboration described below are divided into three main categories of strategic research and innovation partnerships (SRIP), namely:

- I. Digital
- II. Circular
- III. (S)Industry 4.0

Each category is shown in a different colour: for Digital, for Circular and for III. (S)Industry 4.0

I. Digital	II. Circular	III. (S)Industry 4.0
1. Smart cities and communities	3. Networks for the transition to a circular economy	6. Factories of the future
2. Smart buildings and home with wood chain	4 Sustainable food	7. Health – medicine
	5. Sustainable tourism	8. Mobility
		9. Materials as products

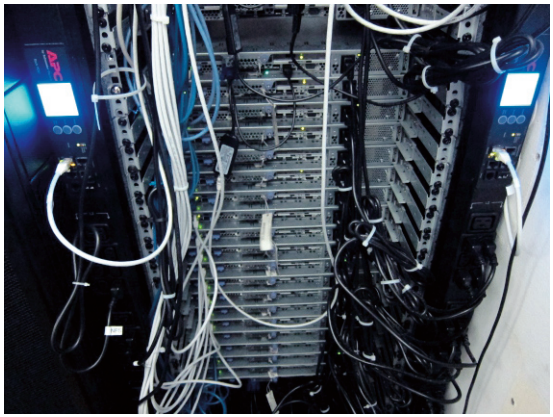
// Departments and their opportunities for business collaboration

// Department of Theoretical Physics (F1)

The Department is focused on particle physics, in particular particle phenomenology, unification of interactions and problems of several bodies, solid state physics, e.g. relaxors, quantum dots, high-temperature superconductivity, nanophysics and complex networks, and soft matter physics and biophysics, i.e. liquid crystal, colloids, DNA, viruses and lipid vesicles.

OFFER FOR INDUSTRY:

- Biophysics of polymers, membranes, gels, colloids and cells
- Strong electronic correlations and superconductivity



The main tool used in the Department of Theoretical Physics are high performance computers to study the issues of particle physics, solid state physics and solid matter physics and biophysics.

// Department of Low and Medium Energy Physics (F2)

The F2 Department is one of the oldest at the Institute. It conducts top-class research in the field of nuclear physics and experimental physics at the level of atoms. The research is carried out on accelerators at the JSI Podgorica Reactor Centre and abroad. The Infrastructure Group for Ionising Radiation Measurements (ISMIS) focuses on measurements of radioactivity in the environment, foodstuffs and various materials, collaborates in dating groundwater and establishes the content of biocomponents in fuels.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Nuclear engineering, energy industry, ecology

OFFER FOR INDUSTRY:

- Archaeology (analysis of antique coins)
- Ferromagnetism in ceramics
- Chemical imaging of biological materials
- Construction of spectrometers
- Lithium-sulfur batteries
- Radioactivity measurement (oncology, nuclear safety)

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Sample analysis with Mössbauer spectroscopy (and establishing the presence of different oxides (F2) - I./1Sample analysis with Mössbauer spectroscopy (and establishing the presence of different oxides (F2) - I./1
- Analyses of the 1 ppm level sensitivity in a cubic micrometre of material and at the micron level (PIXE, RBS, ERDA (F2) - I./1
- Conducting personal dosimetry (F2) - III./7
- Development of digital pulse processor (F2) - I./1
- Imaging of molecular distribution (e.g. pharmaceutical active substances or metabolites with the Megaelectronvolt-Secondary Ion Mass Spectrometry (MeV-SIMS)) (F2) - I./1

// Department of thin films and surfaces (F3)

The principal activity of the Department is research and development of hard protective films, i.e. a few micrometer thick films of very hard materials used to protect tools against wear and tear increasing their life expectancy. Within the Department there is the Hard Coating Centre where respective coatings are applied to tools of their industrial partners.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Metalworking, wood industries, electrical works, electronics and mechatronics, production of plastics

OFFER FOR INDUSTRY:

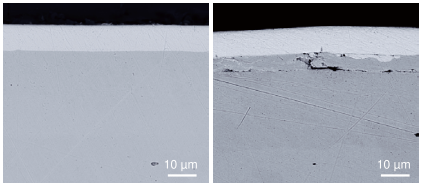
- Analysis of thin films and surfaces: microscopy, topography, hardness
- Analysis of damage on industrial samples
- Deposition of coatings for standard applications
- Development of new customised coatings
- Study of the suitability of coatings for specific applications

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

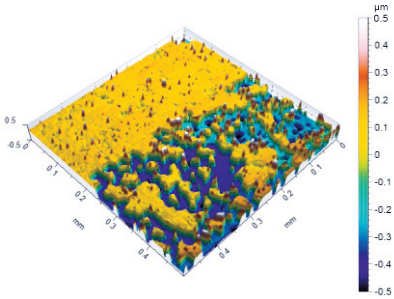
- Contactless and contact topographic analysis: roughness, form, statistics of defects, 3D-view (F3) - III./9
- Interpretation of damage causes (F3) - III./9
- Cutting of a small sample from a tool and subsequent preparation of metallographic cross-section (F3) - III./9
- Literature research of the use of coatings for comparable applications (F3) - III./9
- Measurement of coating adhesion (F3) - III./9
- Measurement of friction coefficient (F3) - III./9
- Measurement of hardness on macro-, micro- and nanoscale; on surface or in cross-section (F3) - III./9
- Deposition of standard coatings for cutting tools (TiN, TiAlN) (F3) - III./9
- Deposition of advanced coating for cutting tools (nanolayer AlTiN, nanocomposite TiAlSiN) (F3) - III./9
- Deposition of coatings on forming tools (punches, bending tools, stamps, pins) (F3) - III./9
- Deposition of CrN coating on tools for the food and pharmaceutical industries - (F3) - III./9
- Deposition of self-lubricating aCN coating on tools where reduced friction coefficient is needed (F3) - III./9
- Non-destructive analysis of large samples (up to 3 kg): optical microscopy and contact profilometry (F3)- III./9
- Optical microscopy of surface and cross-section (F3)- III./9

- Comparative analysis of good piece:poor piece (F3) - III./9
- Comparative analysis of the applicability of different coatings on the same type of tool (F3) - III./9
- Comparison of previous cases of depositing coatings on similar tools (F3) - III./9
- Developing a combination of standard customised coatings (F3) - III./9
- Developing a modification of one of standard customised coatings (F3) - III./9
- Developing a completely new coating for the client (F3) - III./9
- Providing advice regarding suitable protection technology (F3) - III./9
- Scanning electron microscopy of the surface and cross-section; local analysis of chemical composition also included (F3) - III./9

For our industrial partners we deposit six different hard coatings on cutting and forming tools.



Comparative analysis of a good and a poor piece for an industrial customer. Samples were prepared in a cross-section (grinding and polishing) and analysed by a scanning electron microscope.



Surface topography after a partial husking of thin film. The scan was made with a contact profilometer.

// Department of Surface Engineering and Optoelectronics (F4)

The Department focuses on surface treatment of different products and semi-finished products produced by industrial partners from Slovenia and abroad. The researchers use the fourth physical state, i.e. gaseous plasma, for material treatment. Material surfaces are analysed with high-end methods to characterise surfaces and thin films, in particular X-ray photoelectron spectroscopy and Auger electron spectroscopy.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Foodstuff industry, production of plastics, textile industry, wood industry

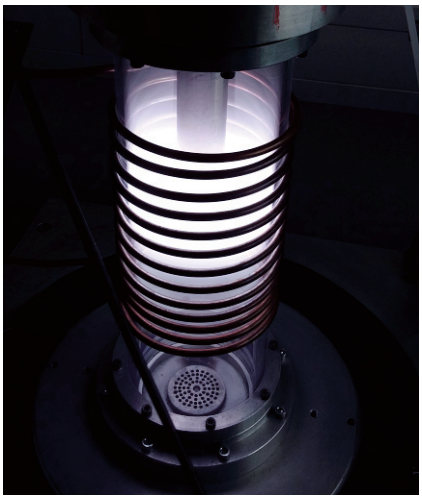
OFFER FOR INDUSTRY:

- Analysis of chemical composition of surface (XPS, SIMS, AFM and SEM analysis)
- Nanostructuring of organic material surfaces
- Environmentally friendly procedures of processing the surfaces of inorganic and organic materials to attain desired characteristics (in particular hydrophilic or hydrophobic properties of surfaces)
- Research and development of a plasma system and control of plasma processes for the needs of industrial partners
- Use of plasma technologies in automotive industry and electrical engineering and in medicine and agri-foodstuffs

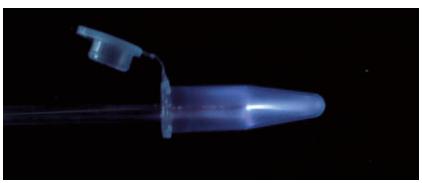
EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Analysis of filaments with plasma etching (F4) - III./6 and III./9
- Dynamically pumped vacuum insulation panels (F4) - III./8 and III./9
- Functionalisation of biomedical samples with thermodynamic non-equilibrium gaseous plasma (F4) - III./7
- Interaction of completely dissociated moderately ionised ammonia plasma with glass-polymer composites (F4) - III./6 and III./8
- Oxidation of metals with reactive oxygen plasma (F4) - III./9
- Plasma treatment of artificial blood vessels (F4) III./7
- Preparation of haemocompatible polymer surfaces for biomedical applications (F4) - III./7
- Preparation of samples with plasma (different types of composites with integrated nanoparticles) (F4) - III./6 and III./9
- Research of measurement methods to determine vacuum insulation panel quality pursuant to the ISO standard draft (F4) - III./9
- Research of nanowire synthesis for regenerative energy cells (F4) - III./8 and III./9
- Development of new materials: New composites for external facade panels – VIP

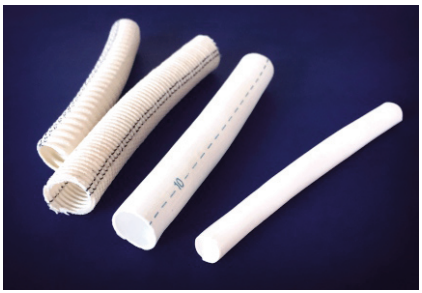
combination of vacuum production and flame-retardant polymer foam (F4) - I./2 and III./9
- Synthesis and functionalisation of composite nanospheres for early detection of neurodegenerative diseases (F4) - III./7
- Superhydrophilicity of surfaces and their use in technological procedures for industrial production (F4) - III./6
- Study of plasma parameters in conditioning internal surfaces of a fusion reactor F4) - III./6
- Use of environmentally friendly plasma technologies and analysis, in particular rough surfaces and mechanical properties of surfaces by using atomic force microscopy (F4) - III./7 and III./9
- Vacuum insulation materials, new insulation materials (F4) - III./6 and III./9
- Charging and discharging of arc in a gas discharge tube at high overvoltage F4) - III./9 and III./6



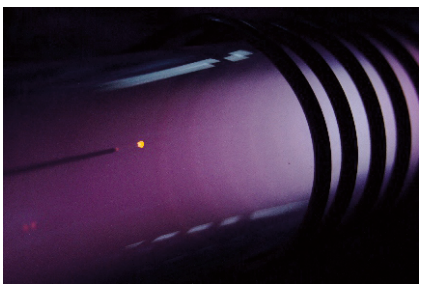
Improving surface properties of different types of materials by using low pressure plasma (wettability, roughness, adhesion, chemical composition of surface).



Use of atmospheric plasma for treating surfaces of complex forms (the figure shows a laboratory apparatus – Eppendorf vessel).



Treatment of textile and medical devices (the figure shows artificial veins made of polymer materials) to attain desired surface properties (more even application of colour, colour-application fastness, biocompatibility of surfaces, etc.).



Control of plasma parameters to optimise plasma processes in production lines and provide better quality of end products.

// Department of Solid State Physics (F5)

The Department focuses on studying the structure and surfaces of solid and soft matter which shows excellent physical properties at different scales: from molecular (nanometric) to crystal (millimetric) In particular, researchers are interested in electronic, optical or magnetic properties. The Department deals with magnetic and electron paramagnetic resonance, micro imaging with magnetic resonance and dielectric spectroscopy of new materials, physics of soft matter, liquid crystal, surfaces and nanostructures and experimental biophysics of complex systems.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Wood industries, civil engineering, metalworking, food industry, photonics industry, nanotechnological companies

OFFER FOR INDUSTRY:

- Detection systems to identify changes in matter and structure in real time
- Photonics technologies
- Metamaterials based on liquid crystal colloids
- Multi-functional materials for actuators and refrigeration apparatus
- New electrocaloric materials for new environmentally friendly dielectric refrigeration technology
- Texture analysis of matter (tablets, wood, liquids, food) with MRI micro-imaging
- Testing the impact of materials on biological systems
- Topological soft matter
- High-entropy alloys

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Analysis of CC Master Pe90270 and Floka white 8000 samples (F5) - III./9
- Detector for counting nanoparticles in the air (F5) - I./1 and III./7
- Photonics technologies (F59) – III./6
- Interactive facade: Use of a coating made of liquid crystal (F5) - I./2, III./6 and III./9
- Method and capacitance sensor for counting aerosol nanoparticles (F5) - I./1 and III./7
- Nanomaterials as a support for ecotechnological optimisation (F5) - II./3 and III./6 and III./9
- Nanotechnologies (F5) - III./6
- Surface coatings – defining the properties of elements and possibilities of collaboration in the field of vacuum thermal insulation (F5) - I./2 and III./9
- Food processing procedures (F5) - II./4
- Sensors (F5) - III./6
- Spectrometer for the automated characterisation of new compounds with the 14N method of nuclear quadrupole resonance (F5) - III./6 and III./9
- Therapeutic, diagnostic and theranostic technologies and products (F5) - III./7

// Department of Complex Matter (F7)

The activity of the Department of Complex Matter includes many different areas, from the synthesis of new types of nanomaterials to fundamental research of basic excitations in complex systems. These range from nano-biological systems and biomolecules to superconductors and nanowires. Experimental methods used by researchers are appropriately very different, i.e. from synthetic chemistry and biomedicine to femtosecond laser spectroscopy and agnetometry.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

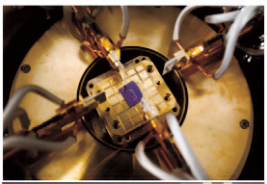
Chemical industry, electric engineering and electronics industry, paper industry and paper processing industry, metal industry and materials industry

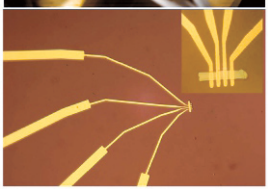
OFFER FOR INDUSTRY:

- Biomedical engineering (dynamic cooling of biological tissues)
- Electron lithography
- Laser medicine (dermatology, aesthetic surgery and stomatology)
- MoSi nanowires
- Nanolithography

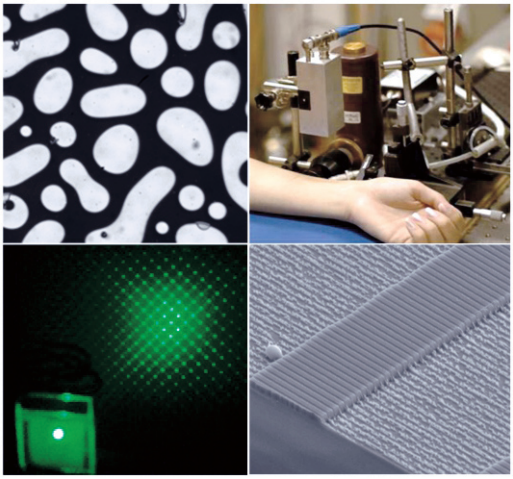
EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Components for industry and medicine (F7) - III./6 and III./7
- Smart coatings and surfaces for civil engineering, medicine, etc. (F7) - I./2, III./7 and III./9
- Smart sensors and nanosensor structures for industrial, biomedicine and environmental applications (F7) - III./6
- Smart systems for environmental and resource management (F7) I./1 and II./3





The programme group "Dynamics of Complex Nanomatter" deals with the research of non-equilibrium dynamics of non-linear complex systems of condensed matter by using a combination of carefully selected experimental and theoretical methods. We produce contacts and circuits on nanomaterial samples using nanolithography. On the samples we conduct measurements of transport, magnetic and optical properties (using the CO Nanocenter equipment).



The research programme Light and Matter focuses on research of soft matter (e.g. liquid crystal, top left), biomedicine optics (e.g. analysis of subcutaneous haemorrhages, right), optical microstructuring of materials (e.g. holographic gratings in elastomer films, bottom left) and research of different materials to be used in photonics (e.g. optical waveguides made of semi-conductive materials, bottom right).

// Department of Reactor Physics (F8)

In the field of reactor physics, the research of the respective Department is focused mostly on developing new methods for calculation of the physical parameters in research and power reactors. The Department conducts research in neutron, photon and electron transport using the Monte Carlo method and preparation of nuclear data for these calculations, advanced nodal methods, homogenisation of basic cell and fuel assembly and methods for precise reconstruction of the power distribution.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

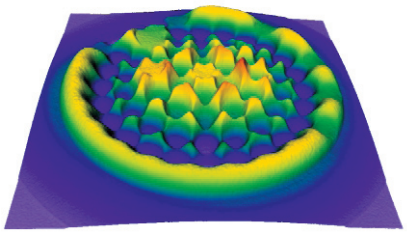
Electrical works, electronics, mechatronics, medicine, energy industry

OFFER FOR INDUSTRY:

- Nuclear reactors (TRIGA reactor in Ljubljana, Krško Nuclear Power Plant)
- Plasma in fusion plants
- Medical physics (analysis of images of positron emission tomography, image-based cancer treatment)
- Testing of resistance of electronic components on the ionising radiation (neutrons and gamma)

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Radiation resistant light (F8) - I./1 and 2 and III./9
- Management strategy related to irradiated nuclear fuel in the Republic of Slovenia (F8) - II./3



Example of the calculation of thermal flux in the TRIGA reactor using the Monte Carlo method.

Associates of the F8 Department in conducting startup test in the Krško Nuclear Power Plant.

// Department of Experimental Particle Physics (F9)

The Department focuses on research of measurements in the field of particles and study basic building blocks of nature and their interactions, and development and use of technologically complex particle detectors. Experiments in the field of physics have increased both in terms of complexity and costs and thus scientists join large associations in international centres of particle physics to conduct them. In these centres, there are accelerators with the highest energies available to humankind. Slovenian researchers cooperate in four experiments in CERN near Geneva, KEK in Tsukuba and DESY in Hamburg. Particle astrophysics is a branch of particle physics using the particle physics methods to study the phenomena in the universe. Slovenian researchers collaborate with the Pierre Auger Observatory in Malargue, Argentina in constructing and test measuring cosmic particles of the highest energies.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

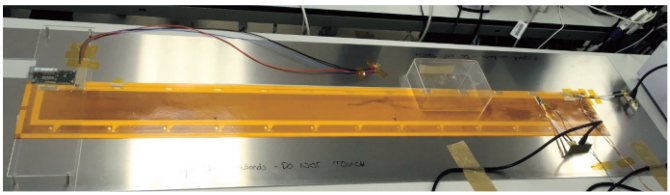
Mobility, medicine

OFFER FOR INDUSTRY:

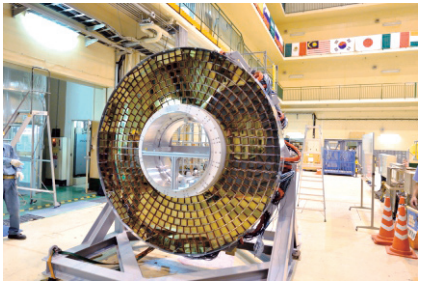
- Particle astrophysics
- Measurement of particles

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Verifying the position of radioactive sources during tumour brachytherapy (F9) - III./7
- Research of reliability of connections in HDI circuits (F9) - I./1 and III./6
- Development of semi-conductive detectors to be used in medicine and high radiation fields (F9) - III./7
- Research and development in the field of direct-drive electric powertrain (F9) - I./1 and III./8

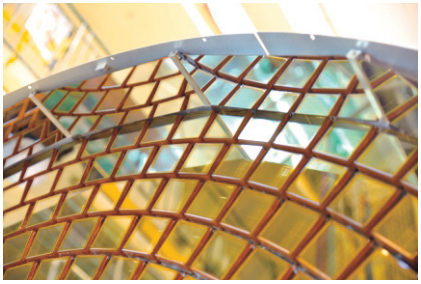


Measurements of signal transmission through flexible circuits, 640Mb per second.

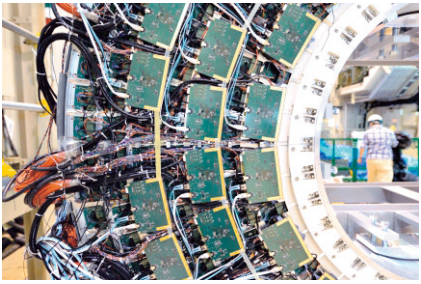


Associates of the Department install a system for the identification of basic particles based on the detection of Cherenkov rings into the magnet of the Belle II spectrometer.

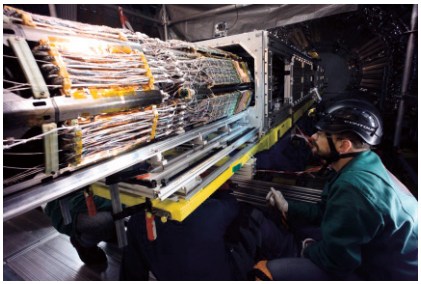
The Cherenkov radiation occurs in the transmission of charged particles with the velocity higher than the speed of light through the silicon aerogel plate into the matter.



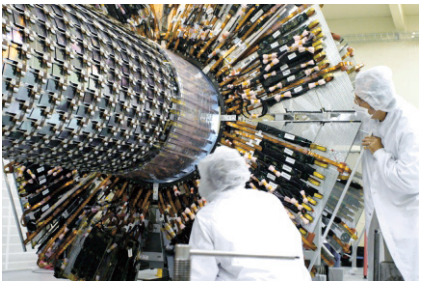
Individual Cherenkov photons are detected by using hybrid photonic detectors.



A complex scanning electronics on the back side of sensors captures and transfers information on the photon hits.



Within the scope of the detector upgrade, the existing interior part will be replaced with a new one which will be made completely of silicon modules.



Silicon detectors and flexible charging cables.

// Department of Inorganic Chemistry and Technology (K1)

The Department of Inorganic Chemistry and Technology is one of the world-leading groups in the field of synthesis of new inorganic compounds containing fluorine. The main fields of research are as follows: reactions in superacids, chemistry of noble gases, chemistry of elements of main groups and synthesis of new inorganic materials with special properties. A significant part of the activity of the group has been devoted to technological and ecological problems in Slovenia.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

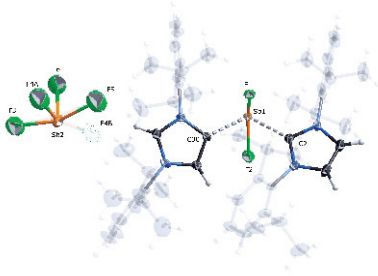
Textile industry, wood industry, cosmetics, glass industry, plastic processors, goldsmith and jewellery sector

OFFER FOR INDUSTRY:

- Chemical analysis:
  - CHNS elemental analysis
  - Determination of fluorine as the main component or in traces
  - Determination of main components
- Process safety
- Synthesis of anode materials for lithium batteries
- Synthesis of inorganic fluorine groups
- Synthesis of heterogeneous acid catalyst
- Technological problems and research for sustainable development:
  - purification of flue gases with the emphasis on desulfurisation
  - preventing the generation and elimination of pollutants in waste incineration;
  - use of waste as secondary raw materials;
  - safety analyses in the field of preventing major accidents involving dangerous substances (process safety), consultancy services for industry.

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Analyses on the Raman microscope (K1) - III./7
- Homogeneity of materials / CRM (K1) - III./9
- Possibility of cooperating with the parent organisation in developing and replacing existing functional groups of medicines – related to the pentafluoro sulfanyl group - SF5 (K1) - III./7
- Data processing and development of waster water treatment technologies (K1) - II./3
- Optimising remediation of landfill sites for materials contaminated with polychlorinated biphenyls (K1) - II./3
- Prevention of major accidents with dangerous substances (obligation laid down by the legislation) (K1) - II./3
- Development of technologies for managing process and waste water (K1) - II./3
- Segments of environmental permits such as simulations of chlorine cloud movements in the event of accident (K1) - II./3



Synthesis of inorganic fluorine groups (reactions of N-heterocyclic carbene SbF3).

Synthesis of heterogeneous acid catalysts (high surface AlF3).

Technological problems (chemical procedures for ore purification).

Research for sustainable development (solar heating and cooling).

Chemical analysis (elemental analyser).

// Department of Physical and Organic Chemistry (K3)

The Department comprises Laboratory of Physical Chemistry and Laboratory of Organic and Bioorganic Chemistry. In the field of physical chemistry, the Department is focused on the experimental and theoretical study of elementary physicochemical processes on surfaces of solid matter and in atmospheric processes. The main attention in the field of organic chemistry is directed to the halogenated, in particular fluorinated, organic molecules. Special attention is dedicated to the green organic chemistry by investigating environmentally friendly moderators (hydrogen peroxide) and reagents for halogenation.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Electrical works, mechanical engineering, electronics and mechatronics, wood industry, manufacturers of plastics

OFFER FOR INDUSTRY:

- Car cosmetics
- Methods of halogenation of organic molecules
- Potential antimalarials
- Anti-corrosion protection
- Synthesis of organic peroxides
- Copper, aluminum and steel alloys

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Anti-corrosion coatings (for 1. starters, 2. magnets) (K3) - III./9
- Searching for alternatives to passivation procedures (K3) - III./9
- Optimisation in the stator production line: solutions extending the service life of an electrode (K3) - III./9
- Increasing the hardness of non-corrodible sheet metal with material thickness of 0.6 or 0.5 mm (K3) - III./9
- Frame surface protection (K3) - III./9
- Coatings for increasing the service life of rotors in coolants (K3) - III./9

// Department of Electronic Ceramics (K5)

The Department conducts research and collaborates in research and development projects and education programmes in the field of synthesis, properties and use of materials for electronics and energetics, in particular complex materials and structures providing several functions (multi-functional materials). In particular, these are ceramic piezoelectrics, ferroelectrics, relaxors, multiferroics and conductive oxides. The research focuses on the creation of properties through synthesis and structure at the nano, micro, and macro levels The Department also studies the basics of processes for the preparation of pressure sensors, ceramic microelectromechanic systems (MEMS) and transparent electronics.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

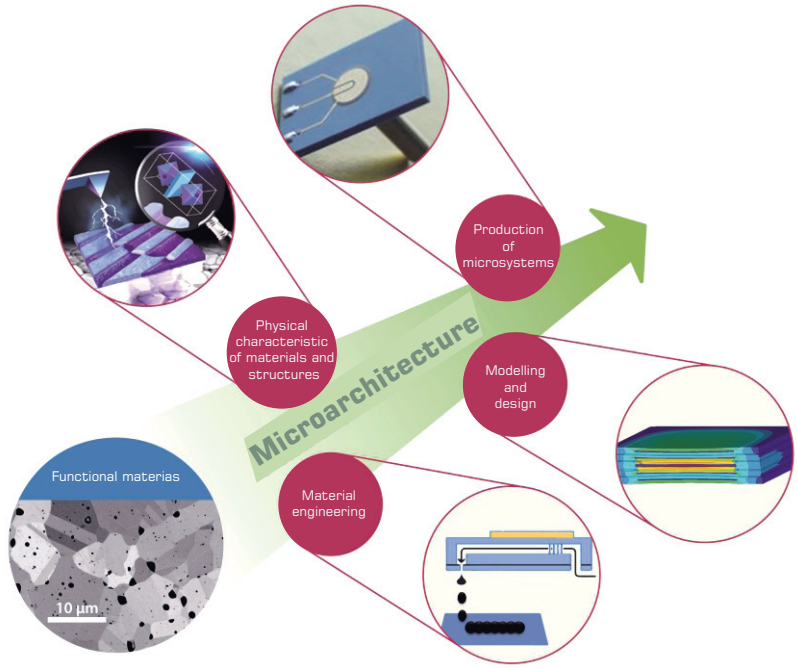
Electronic industry, electric power industry

OFFER FOR INDUSTRY:

- Electrocaloric materials and elements for refrigeration devices
- Materials and technologies for the intended use, e.g.: porous ceramics, multi-layer ceramic electronic components, transparent electronics, ceramic sensors and actuators, ceramic MEMS and other microsystems
- Microstructural analysis of materials
- Designing thin-layer components of transparent electronics by inkjetting
- Piezoelectrical materials and elements including environmentally friendly lead-free piezoelectrics and high-temperature piezoelectrics
- Various technologies to prepare volume ceramics, thick and thin layers and layer structures

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Electrocaloric materials and elements for refrigeration devices (K5) - I./1 and I./2
- Ceramic and functional materials within the scope of the modern manufacturing technology for materials (K5) - III./6
- Ceramic materials in the field of multi-component smart materials (K5) - III./9
- The field of application-specific sensors and actuators, integration of various sensors, actuators and other microsystems (K5) - I./1, I./2, III./6, III./7, III./8
- Pressure sensors (and other sensors) for air-conditioners (K5) - I./1 and I./2



Scheme of the integration of functional materials in ceramic microsystems.

// Department for Nanostructured Materials (K7)

The basic research in the Department focuses on inorganic materials with specific physical properties that are a consequence of their structural and chemical phenomena at the nanostructural and atomic levels. The main research paradigm that we follow is to find the relationship between the functional performance of the material and its physical, structural and chemical properties by using advanced electron microscopy techniques and ab-initio modelling to reveal phenomena at the nanoscale.
The fields of research involve natural and manufactured ceramic materials as well as metals and intermetallic compounds. Specifically, we target the areas of metals and intermetallic compound, with strong emphasis on permanent bulk magnets, magnetic nanostructures processed with electrochemical methods, magnetocalorics and complex metallic alloys. In the area of biomaterials we conduct research of biocompatible materials for regenerative medicine and multifunctional hybrid nanomaterials for theranostic purposes. We conduct research in the area of functional and structural ceramic, as for example ceramics to be used in the future fusion reactors. In the area of the electron ceramic we develop varistor and thermoelectric materials. In the field of environment, we are focused on the fabrication of highly sensitive sensors for organic pollutants and nanostructured foto-electrocatalytic systems for wastewater treatment.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Civil engineering, metalworking, electrical works, automotive industries, pharmaceutical industry, medicine, etc.

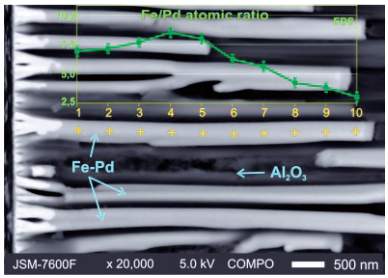
OFFER FOR INDUSTRY:

- Materials for bone replacement and reconstruction
- Modelling of modern materials of technological interest: spintronics, nanowires
- Modification of the properties of colloid particles
- Technologies for improving definitive properties of magnets with significant reduction in heavy rare earths
- Materials of technological interest (intermetallic magnetic alloys, metallic glasses, semi-conductive ZnO ceramics, varistors)

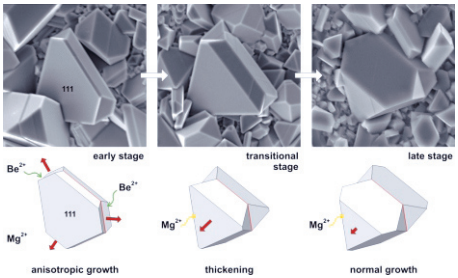
EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Analysis of magnets (K7) - III./9
- Determination of the content of metals in artificial resins or coatings (K7) - III./9
- Refrigeration systems based on the magnetocaloric effect (K7) - III./6
- Chemical and morphological analysis of surface cross-sections (K7) - III./9
- Ceramic coatings (K7) - III./9
- Magnets without rare earths (K7) - III./9
- Magnets of new generation – high-temperature NdFeB magnets (K7) - III./9
- Materials and technologies for the use of thick layer varistors and oxide thermoelectrics based on ZnO (K7) - III./9
- Microreactors based on titanium oxide (K7) - II./3

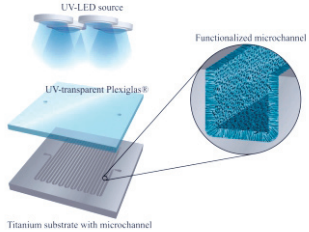
- Multipole NdFeB plastomagnet for rotor application (K7) - III./8 and III./9
- Nanosensors for humidity, Co2/O2, formaldehyde (K7) - I./1 and III./9
- Flame-retardant polymer foams/coatings (K7) - III./9
- Low doped ZnO ceramics for energy varistors (K7) - III./9
- Movable entrance platform – application with magnets (K7) - I./1 and I./2
- Prevention of calcination with new materials, coatings (K7) - III./9
- Coatings and layers (K7) - III./9
- Theranostic systems for cancer treatment based on hybrid nanoparticles (K7)-III./7
- Heat converter -> Optimisation related to diffusion of cooper into steel / heat converters without copper for applications used to extract potable water (K7) - II./3 and III./9
- Use of new technologies to prevent encrustation on industrial systems (K7) - III./6
- Use of rare earths alloys and transition metals for high-energy permanent magnets (K7) - III./6
- Highly coercive Nd-Fe-B plastic bonded neodymium magnets for automotive applications (K7) - III./8 and III./9
- Protected permanent magnets for advanced applications at high temperatures (K7) - III./9



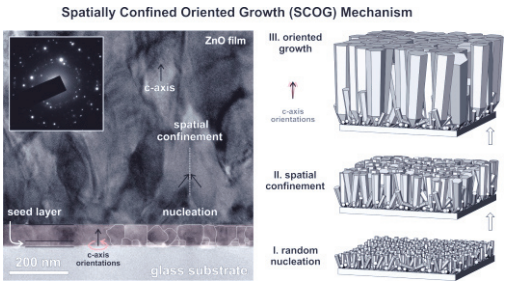
High resolution FEGSEM image of nanorods for Fe-Pd alloys with superimposed diagram indicating a change of Fe/Pd atomic ratio along the stick (points 1-10); the results were achieved with an optimised low-voltage quantitative elemental EDS analysis at the submicrometre analytical spatial resolution.



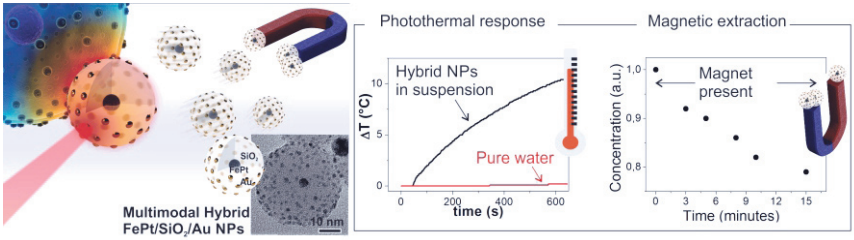
Development (111) of twin crystals in a spinel. As long as a dopant causing a twin boundary is available, the grain exceedingly grows in the direction of twin and develops a plane form which is unusual for a cubic spinel. Later, the grain thickens through the Ostwald mechanism.



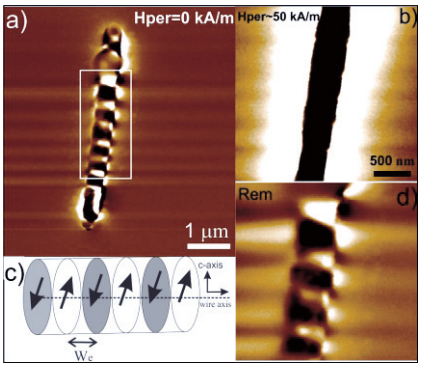
Scheme of photocatalytic microreactor.



TEM image of nucleation layer and initial stages of ZnO layers with schematic display of growth mechanism under spatially limited conditions. The SCOG mechanism has three levels: (i) random orientation, (ii) spatial limitation, and (iii) oriented growth.



Multi-modal hybrid nanoparticles for nanomedicine applications with a combined photo/thermal effect and ability of their manipulation with external magnetic field.



a) Scan of a Co-Pt nanowire made by using magnetic force microscope (MFM). b) Diagram of possible modulations of magnetisation within one nanowire, c) Co-Pt nanowire in the state of saturated magnetisation in the used Hper≈ 50 kA/m magnetic field. d) Remanent magnetisation of one Co-Pt nanowire.

// Department of Synthesis of Materials (K8)

Research of the Department is focused on developing advanced oxide materials demonstrating useful electromagnetic properties. The purpose of research is to acquire knowledge on the chemistry of materials to design new materials with desired properties. The acquired knowledge of the controlled synthesis of basic materials is upgraded with the knowledge on adaptation of their chemical properties for the synthesis of composite and/or multi-functional materials.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Graphic industry, manufacturers of products made of plastics, optics

OFFER FOR INDUSTRY:

- Fluorescent materials
- Magnetic materials for microwave and millimeter field
- Semi-conductive ceramics
- Synthesis and functionalisation of nanoparticles, magnetic liquids, magnet nanocomposites
- Multi-functional materials

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Improvement of technological processes: use of magnetic particles for the immobilisation of catalysts and enzymes, magnetic separation of target molecules/microorganisms from mixtures (K8) - III./7
- Nanoparticles as a contrast agent for NMR (K8) - III./7
- Nanostructures for magnetic delivery of medicinal substances (K8) - III./7
- Optimisation of production procedure for the preparation of PTC resistors (K8) - III./6
- Nanocarbon project (K8) - II./3
- Development of photocatalytic superparamagnetic nanocomposites for the emission reduction procedures (K8) - II./3
- Collaboration in developing magnetic nanoparticles for the introduction of heritable material in cells (K8) - III./7

// Advanced Materials Department (K9)

At the Department we investigate novel materials through an understanding of the mutual dependence of their structural, microstructural and functional characteristics. Modern technologies that enable the synthesis of materials with atomic and microscale precision are used to prepare pre-designed structural 3D materials, thin films and nanoparticles with the desired crystal structure, chemical composition, microstructure and morphology. Among our important objectives is the development of i) novel functional oxide materials for various electronic applications, ii) new materials with improved antibacterial and photocatalytic effects, iii) new materials for efficient energy conversion and iv) heat insulation materials with improved properties and sustainability.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Electronics, energy conversion and conservation, civil engineering, glass industry, biomedicine

OFFER FOR INDUSTRY:

- Study of materials processing for bulk components and thin films
- Materials for ceramic capacitors, piezoactuators, microwave materials etc.
- Defined-shape functional oxide (nano)particles
- Self-cleaning and antibacterial coatings for household appliances and civil engineering
- Antibacterial biomaterials and biomaterials for tissue engineering and regenerative medicine
- Research of mineral fibres for sound and thermal insulation
- Sustainable thermal insulation materials and processes for their preparation, circular economy principles
- Research of vitreous materials

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Thin-Film-Energy-Storage Device on the basis of PLZT and Cu-electrodes (K9) III./6
- High K dielectrics for mobile phone base stations (K9) III./6
- High dielectric constant ferroelectric material (K9) III./6
- LTCC materials for high frequency applications (K9) III./6
- LTCC materials for multilayer LC filters (K9) III./6
- Relaxor-based tunable materials (K9) III./6
- Temperature stable dielectrics with improved dielectric properties (K9) III./6
- New materials for energy conversion: oxide semiconducting thermoelectrics (K9) III./6
- Investigation of materials and processes in MLC manufacturing (K9) III./6

- Self-cleaning antibacterial photocatalytic coatings in whitewear production (K9) III./6
- Antibacterial surface protection in water based media (K9) III./6
- Antibacterial surface protection in refrigerators (K9) III./6
- Development and characterization of mineral wool fibres (K9) III./6
- Development of procedures for economically efficient use of waste mineral wool from production (K9) III./6
- Recovery of calcium oxide from electric arc furnace slag (K9) III./6
- Investigation of rare earth alloys and related compounds (K9) III./6
- Technological characterization test of ashes for verification of usability in the process of rock wool production (K9) III./6

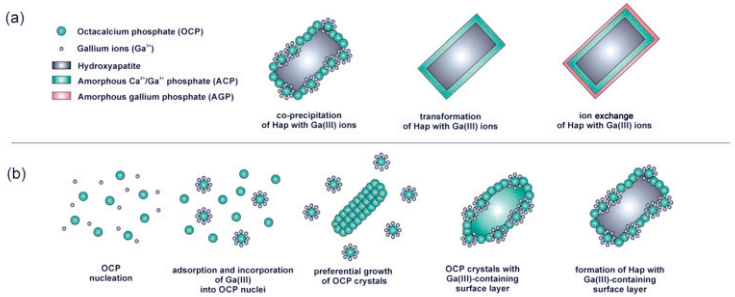
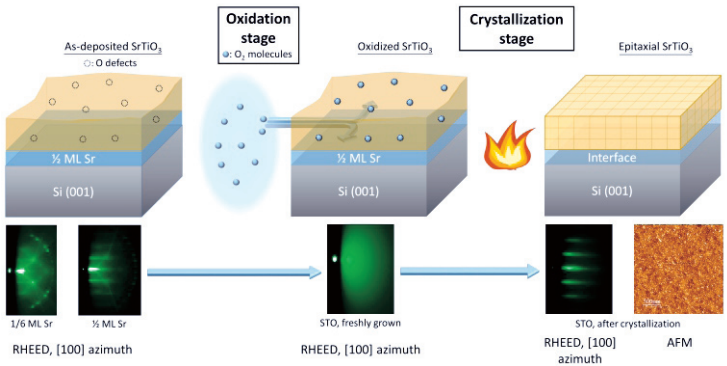
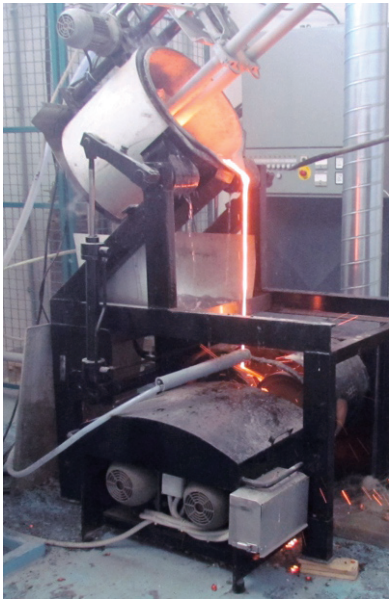


Illustration of the structure of hydroxyapatite with incorporated Ga3+ ions obtained by coprecipitation, transformation and ion exchange with Ga3+ ions and b) the mechanism of formation of hydroxyapatite with incorporated Ga3+ ions co-precipitated nanocrystals.



Graphical scheme of the strontium titanate oxide (STO) growth process. The STO is grown on the 1/2 ML Sr/Si surface, and it consists of STO deposition, oxidation and crystallization phases, which are adjusted to minimize interface reactions and to obtain the most optimal crystalline quality. Below the scheme, reflection high-energy electron diffraction (RHEED) patterns can be seen for the deposition of the Sr buffer layer (left), the freshly grown STO (center) and the crystallized STO (right), along with an atomic force microscope (AFM) image after the final stage of the growth process.



Preparation of mineral fibres for heat insulation applications: Fiberization of the melt on two-wheel spinner with frequency controller.

// Department of Environmental Sciences (O2)

The Department of Environmental Sciences conducts research of basic natural mechanisms, from cells to geological systems, their interactions and responses of natural system to human activities. It also collaborates in developing technical solutions of environmental issues and environmental management. Research is interdisciplinary and multidisciplinary. Within the Department, there is also the ERA chair of ISO-FOOD for quality, safety and traceability of foodstuffs using isotopic techniques, Mass Spectrometry Centre, Centre for Radon and the ecological laboratory with the ELME mobile unit.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Processing industry, environmental technologies, food technology, agriculture, forestry, hydrology, processing of minerals, processing of waste materials and recycling, production of inorganic, organic and composite materials, energy sector, development of sensors, monitoring of natural, residential and working environment, biotechnological processing of secondary materials in the food industry, production of building materials etc.

OFFER FOR INDUSTRY:

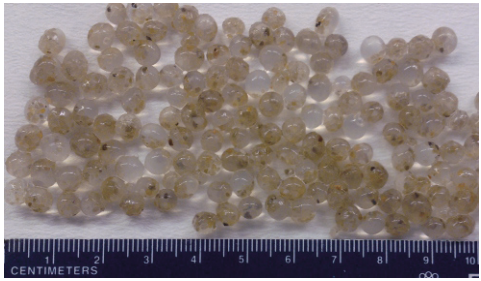
- Analysis of circulation of compounds, elements and isotopes in nature and technological processes
- Analytical chemistry (organic, inorganic analysis, analysis of element speciation, isotopic structure of elements, radionuclides, mercury, bioanalysis, production of radioisotopes)
- Identification, development and modification of microorganisms for biotechnological processes
- Control measurements in the environment
- Evaluation of environmental interventions
- Risk assessment
- Supporting the development of clean technologies and waste management
- Supporting water management
- Studies of interconnections between environment, health and food
- Safety and traceability of foodstuffs in the Slovenian market
- Mercury in food and the environment

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

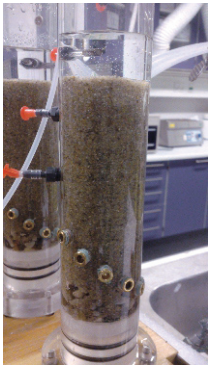
- Analysis of minerals, extracts and residue after processing (O2) - II./3
- Analysis of water, ground, earths: organic (natural substances, persistent pollutants, medicinal substances and their products of transformation), inorganic (elements, speciation), isotopic (O2) - II./3
- Elementary and isotopic analysis of foodstuffs and food supplements and their individual components to determine the authenticity and geographical origin (O2) - II.

- Integrated methodology for remediation of environment burdened with past industrial activities (O2) - II./3
- Implementation of advisory activity in the field of assessing environmental impacts and providing production safety (O2) - II./3
- Quality of urban living (O2) - I./1
- Characterisation of alloys (O2) - II./3
- Chemical characterisation of waste (sediments, technological sludge, industrial and municipal wastewater) as a raw material input and during the processing to the end product (O2) - II./3
- Measurements in the environment – horizontal themes in all SRIPs (O2)
- Advanced living environment (O2) - I./2
- Processing of waste products from the food industry into new products with high added value (O2) - II./3
- Use of new materials made of recycled and industrial waste raw materials (O2) - II./3

Different methods of immobilisation provide a certain type of bacteria to operate more efficiently in a certain environment and for a certain application. There are three types of carriers shown: simple, based on alginates, medium complex – bacteria are cross-linked in the gelatinous matrix within a porous hard mineral matrix and complex – bacteria are attached in the pores of hard mineral matrix in a form of artificial biofilms.



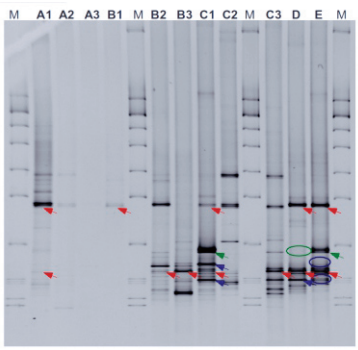
If they are to be used in filters of a candle shape, alginate carriers must be also loaded to be appropriately positioned in a column. This is achieved by adding certain inserts with bacteria.



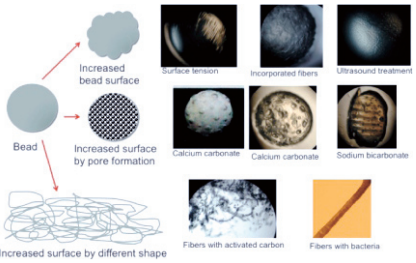
The experimental column of up to 300 ml is shown with one half filled up with sand and the other half with carriers containing pesticide-decomposing bacteria.

Columns are filled with up with different types of carriers, which include bacteria of the Aminobacter genus.

Different carriers are shown to which we added bacteria using electrostatic interactions. Measurements are based on capturing CO2 in layers (test tubes in small vessels) and scintillation measurement of captured carbonate.



Profiles are shown of microbial community after the succession. We studied the impact of preliminary force attached bacteria on the development of community. The DGGE profile (Denaturing Gradient Gel Electrophoresis) of PCR multiplies gels for 16S rRNA



The methods to increase the porosity of alginate carriers with added bacteria are shown. Chemical (dissolution of carbonate matrix in acid) and physical processes (ultrasonic matrix processing) were used.

// Department of Automatics, Biocybernetics, and Robotics (E1)

The Department generates different knowledge on the movement of robots and people and uses it in industry, high-level sport and medicine. This knowledge and extensive experience are used in contemporary technical fields, such as advanced automation, intelligent and service robotics and target areas of biocybernetics and ergonomics. The Department develops and produces electric stimulators used all over the world.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Electrical works, electronics and mechatronics, glass industry, metalworking, manufacturer of plastic products

OFFER FOR INDUSTRY:

- Biorobotic model of the vertical jump
- Kinematics of the human shoulder assembly
- Software for robotic trajectories in applying an adhesive to the sole of a shoe.
- Distinguishing objects on humanoid robots
- Robot learning of sensomotoric skills
- Fire explosion simulator
- Control of robots

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Adaptive automation (E1) - III./6
- Analysis of production processes and design of automation in the lighting equipment production in the glass factory (E1) - III./6
- Automation (E1) - III./6
- Automation and robotisation of production (E1) - III./6
- Automation and robotisation in civil engineering (E1) - III./6
- Supplement and change of control and operation system for a production line (E1) - III./6
- Production of electric motors (E1) - III./6
- Production of specifications and designing solutions for a new system of automated preparation, control and operation (E1)
- Sustainable competitive productions – EU projects - II./3 and III./6
- Smart factories (E1) - III./6
- Transfer of rotation --> translation movements (E1) - III./6
- Development of a device for automated preblowing of glass products (E1) - III./6
- Reconfigurable and modular robot-based service and assembly (E1) - III./6
- Relocation of the control and operation system into a new factory (E1) - III./6
- System for the automated integrated simultaneous production of various products (E1) - III./6
- Factories of the future (E1) - III./6
- Sustainable production – EU projects - III./6

// Department of Systems and Control (E2)

The activities of the Department of Systems and Control include analysis, control and optimisation of various systems and processes. Several activities are performed within this frame: (i) research and development of new methods and algorithms for automated control, (ii) development of procedures and software tools to support the design and building of control systems, (iii) development of special measuring and control modules, and (iv) design of computer aided systems for control and supervision of ,machines, devices, and industrial and other processes. In its thirty years of existence, the Department has produced approximately 200 projects for domestic and foreign partners.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

ICT, electrical works, electronics and mechatronics, production of plastic products, mechanical engineering

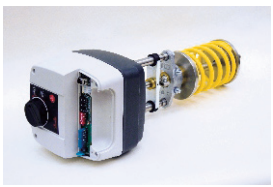
OFFER FOR INDUSTRY:

- Declaration and localisation of errors in technical systems and processes
- Assistive and implementation technology for management systems
- Computerised control of production
- Development of devices and products
- Control and optimisation of complex processes

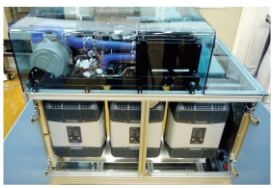
EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Algorithm for forecasting the room occupancy (E2) - I./1
- Optimisation of system operation in the field of environment (E2) - I./1
- Optimisation of the polymerisation process (E2) - I./1
- Optimisation of the processes in high-shelf warehouses (E2) - I./1
- Smart buildings (cogeneration, energy stations) (E2) - I./2
- Optimisation processes: Optimisation of production (E2) - III./6
- Development of the module for heating up fuel cell stacks (E2) - I./1

System for the automated final quality control of products in an electric motor factory.



Electronic assembly for operating the control valve operator.



PEM fuel-cell-driven 8kW power generator.

// Artificial Intelligence Laboratory (E3)

The Artificial Intelligence Laboratory conducts research and development in collaboration with academic organisations and companies in Slovenia and abroad. The fields of work include information technologies with the focus on artificial intelligence technologies. The major fields of research and development are as follows: (a) data analysis with the focus on text, web, multimedia and dynamic data, (b) techniques for analysing large quantities of data in real time, (c) visualization of complex data, (d) semantic technologies, (e) language technologies.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

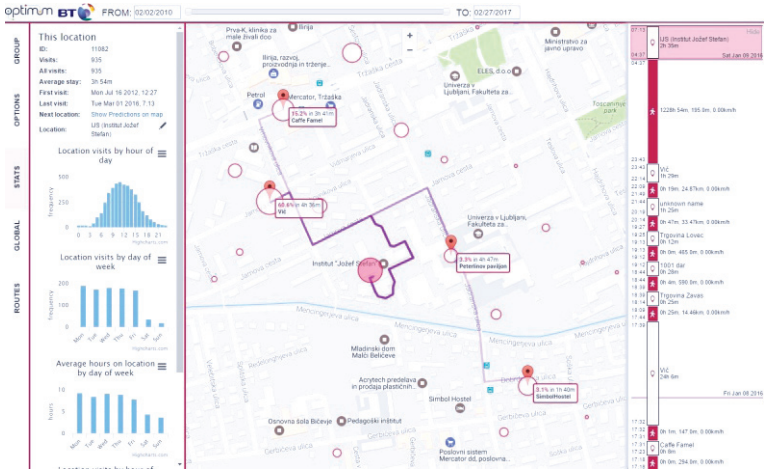
Energy sector, tourism, media, traffic and mobility, agriculture

OFFER FOR INDUSTRY:

- Analysis of social networks
- Analysis of large quantities of data in real time
- Language technologies
- Logical conclusion
- Discovery of knowledge from data, texts and World Wide Web
- Sensor networks
- Machine learning
- Artificial intelligence
- Knowledge management
- Visualisation of data

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Development and implementation of algorithms for scalable analysis of data streams (E3) - I./1
- Artificial intelligence and applications in health care (E3) - I./1 and III./7



The tool for displaying mobility samples (right), statistics of visits to a certain location (left), and forecasting the following location on the path (middle).

The Videolectures Explorer tool shows the structure of lectures published on the Videolectures.NET portal and their statistical data. On the left, there are keywords used in searching, while on the right there is the structure of connections between lectures (landscape) with main characteristics highlighted.

// Laboratory of Open Systems and Networks (E5)

The activities of the Laboratory are focused on research and development of networks of the next generation, integrated systems and services, and applications of information society, in particular those providing security and privacy and more efficient and incisive realisation of the life-long learning concept. Within the scope of international projects, it develops the infrastructure for safe use of cross-border services in the field of e-education, e-banking, e-health-care, and public services for companies. The researchers have developed the EDUFORS cloud-based platform and the FOREVICA serious game for education and training in the field of digital forensics.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

ICT, e-Service, e-administration, etc.

OFFER FOR INDUSTRY:

- Digital forensics
- E-education technologies
- Design and development of open systems based on multimedia applications and their integration in networks with added value
- Design and development of the system for efficient use of electricity
- Design and development of security infrastructure and trustworthy e-services
- Networks of the next generation and solutions for the information security problems
- Prevention of cybercrime

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Study on the challenges of the Internet of the future (E5) - I./1
- Security, privacy and reliability of information networks – Smart Grids (E5) - I./1

// Department of Communication Systems (E6)

The core activities of the Department include research, design and development of next-generation telecommunication networks, technologies and services; wireless communication, embedded and sensor systems; and new procedures for parallel and distributed computing. Within these activities our research work includes the development of methods and software tools for modelling, simulation, analysis and synthesis of communication systems, computer simulations in the field of medicine to support surgery procedures, and equipment and procedures for advanced bio-signal processing.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

ICT, energy sector, medicine and medical devices, electronics, mobility

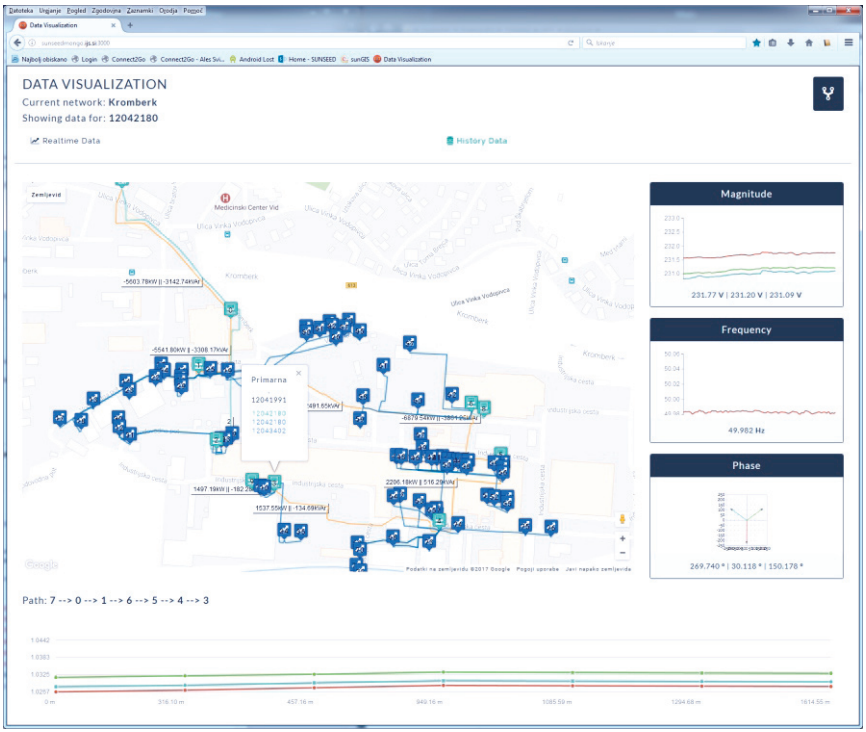
OFFER FOR INDUSTRY:

- Wireless sensor networks
- Formal methods for modelling, analysis and synthesis of discrete systems
- Communication protocols, services and applications
- Measurements and processing of bio-signals
- Modular platform for wireless sensor networks
- Software tools for testing, modelling and simulation of communication systems
- Computer modelling and simulation in medicine
- Telecommunication systems and networks
- Parallel and distributed systems

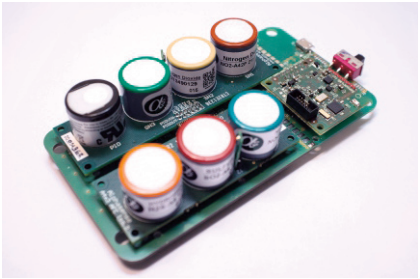
EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Bistable switches (E6) - I./1
- Industrialisation of innovations (E6) - I./1 and III./6
- Drawing up of the study "Analysing the prevention of glaze-ice formation through operational measures" (E6) - I./1
- Implementation of the project "Dynamic assessment of thermal conditions of power line cables in glaze-ice conditions" (E6) - I./1
- Communication systems, design, production, tests of small series of electronic assemblies (E6) - I./1
- Method of final elements to optimise the procedure of modelling the drawing process (E6) - III./6
- Module for exporting reports related to the MobECG application (E6) - I./1
- Advanced techniques of ray tracing to characterise radio signals (E6) - I./1
- Cooling of overhead line conductors in horizontal wind speed below 0.6m/s (E6) - I. 1
- Optimisation of channels for DMR networks in the 146–174 MHz frequency range (E6) - I./1

- The Vesna platform and sensors for changing air quality (E6) - I./1 and II./3
- Installation of networks for pollution monitoring (E6) - I./1 and II./
- Sensors for analysing water in a washing machine (E6) - I./1
- System for mobile monitoring of vital physiologic parameters and environment context (E6) - II./3
- Study of propagation and topologies for wireless sensor networks in non-licensed frequency bands (E6) - I./1
- Technology for implementing an intelligent mobile home of the next generation (E6) - I./1
- Multi-functional body sensor (E6) - III./7
- Verification of the antennae tracing system simulator (E6) - I./1



Three-phase status estimating device in a distribution network with software for analysing and visualisation of network status.



Mobile sensor device and mobile application for air quality monitoring.

Mobile medical device for permanent and precise heart rate monitoring.

SPM and PMC measuring devices supporting the operation of smart energy networks.

// Department of Computer Systems (E7)

The Department focuses on the research of advanced computer structures and high performance algorithms for massive-data processing and systems for effective human-computer interaction. Researchers draw attention to self-repairing and self-organising systems, modelling and optimisation of complex, dynamic and nondeterministic systems. Within the respective research, applications in the field of production, transport, energy, environmental sustainability, bioinformatics, health and medicine are developed. In its research, the Department collaborates with companies, such as Hyb, MedicoApps, Gorenje, BSH hišni aparati, XLAB, etc.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Electronics and mechatronics, electric works, traffic

OFFER FOR INDUSTRY:

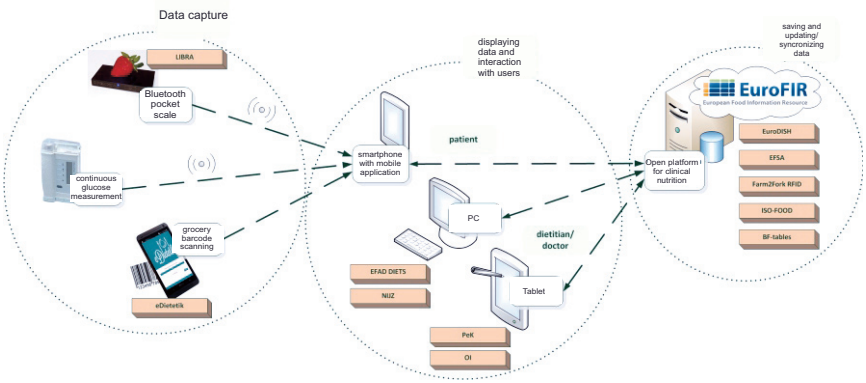
- Optimisation methods
- Parallel computing
- Testing electronic circuits and systems
- Computer architectures
- Computer vision
- Integrated systems

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

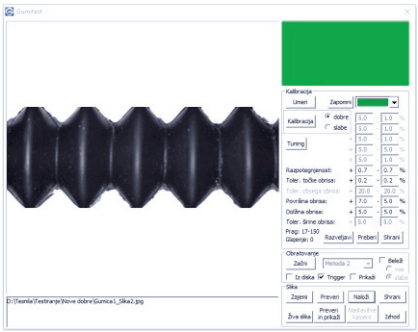
- Aerodynamic geometrical optimisation of a suction unit propeller (E7) - III./6
- Analysis of possibilities to upgrade the A-portal on-line platform (E7) - I./1
- Application for easy control of heating system operation and costs (E7) - I./2
- Design of a heat exchanger between a heating medium and heated water (E7) - III./6
- Construction of industrial platform for an optimal placement of an industrial lighting system in facilities (E7) - III./6
- Implementation of a pilot model to optimise design and termination of cooktop production (E7) - III./6
- Quality control with machine vision (E7) - III./6
- Control of core installation in a closed mould (E7) - III./6
- Low-power miniaturised contactless BIOimpedance Measurement Device - BIOMeD (E7) - III./6
- Measurement of suitability of a mould in terms of its grey and nodular cast (E7) III./6
- Modelling, simulation and optimisation of production processes (E7) - III./6
- Control and management of processes and logistics and optimisation of processes and systems (E7) - III./6 and I./1
- Assessment of panels in terms of their suitability of use (E7) - III./6
- Optimisation of the level of availability of the whole heterogeneous and complex

production system (E7) - III./6
- Optimisation of absorbent composite materials (E7) - III./6
- Optimisation of distribution and search for optimum composite material for protection against EMC (E7) - III./6 and III./9
- Optimisation of distribution and search for optimum composite material for protection against EMC (E7) - III./6
- Optimisation of the construction of high-shelf warehouses (E7) - III./6
- Optimisation of electric motor clutch plates (E7) - III./6
- Optimisation of packaging, loading and transport of elements of prefabs (E7) - I./1 and III./6
- Optimisation of designing the production process (E7) - III./6
- Optimisation of production/sale – dynamic (prompt) responding to changes of orders (E7) I./1 and III./6
- Optimisation/minimisation of the number/form of facade elements (E7) - III./6 and I./2
- Optimisation methods – Assistance in simulations and optimisations (MKE) and management of complex problems of signal, procedure, data processing – datamining, etc. (E7) - I./1 and III./6
- Development and construction of a simulator for a refrigeration device (3P) (E7) - III./6
- Development of an intelligent system for reviewing the status of sources and equipment and their management (E7) - III./6
- Development of key components of new "high efficiency" generation of environmentally friendly alternators (E7) - III./6 and II./3
- Development of an optimisation system for designing construction elements (E7) - III./6
- Self-repairing circuits (E7) - III./6
- Signal safety device as per SIL4 standard (E7) - I./1 and III./8
- Simulations of product design (E7) - III./6
- Machine vision: identification of errors in rubber products (E7) - III./6
- Tests in electronics (E7) - III./6
- Toshl: providing information on the cheapest products according to stores. (E7) - I./1
- Design of the model for forecasting a service life of bearings of a vacuum cleaner compressor motor (E7) III./6
- Protective housing of the ICT hub resistant to EM radiation and EM tapping (E7) - I./1 and III./6

Algorithms and applications for traffic steering.



Open platform for clinical nutrition with different domestic and international eHealth projects.



Machine vision and analysis of images for quality control.

Rehabilitation computer game.

// Department of Knowledge Technologies (E8)

The Department of Knowledge Technologies focuses on methods of data analysis and machine learning to discover interesting samples and new data-based knowledge. It also develops systems to record, process and use the knowledge thus acquired. In addition to the respective knowledge technologies which are mostly based on methods of artificial intelligence and machine learning, it also develops applications of these technologies in the field of environmental science, medicine and health care protection, biomedicine and bioinformatics, economy and marketing, linguistics and digital humanities.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Energy sector, ICT, food-processing industry, transport, civil engineering and spatial planning, marketing and media, medicine and health care

OFFER FOR INDUSTRY:

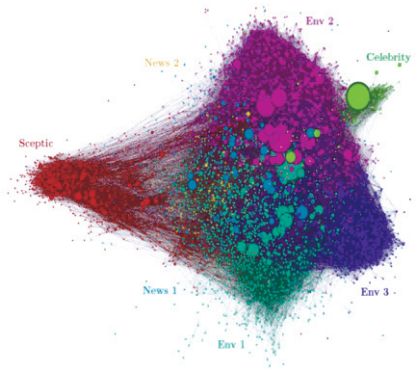
- Language technologies
- Support to decision-making
- Text, web and multimedia datamining
- Datamining and machine learning
- Knowledge management

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Designing tools and procedures for participatory detection of needs of citizens using smart/mobile tools and applications. This segment also includes the analysis of digital footprints (social networks, web forums, etc.) by using "big data" analysis and concepts to analyse behavioural patterns and detection of perception of citizens. (E8) - I./2
- To increase the use of alternative energy sources, the so-called smart power grid must be constructed. An important element of the respective grid is the ability to foresee and forecast the production of individual power plants as well as the requirements of network transmission capacities and the needs of end-users. This type of forecast can be efficiently implemented by using methods and approaches of datamining and machine learning. (E8) II./3
- Development of analytical tools (machine learning, datamining) for data from sensor systems to capture physiochemical environmental parameters affecting the health and well-being (E8) - I./2
- Development of methods and tools for data analysis, predictive modelling, datamining and support to decision-making and their use in the field of transport and energetics. (E8) - I./2
- Development of the system to analyse consumer wishes, needs and behaviour, and promote participation in designing new products. Knowing consumer wishes, needs and behaviour is crucial in providing economic performance of food-producing and processing companies. This dedicated research is very complex and expensive. However, a similar type of research may be conducted at a significantly

significantly lower price by using modern information technologies for web mining and sentiment analysis. (E8) - II./4

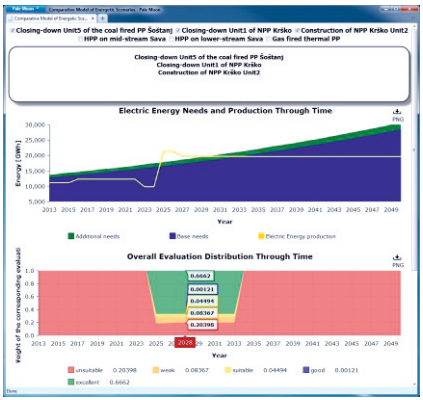
- Development of the system for analysing, modelling and smart designing of production and food-processing processes. To a large extent, the efficiency of food production and processing depends on the efficiency of production and processing processes applied and by developing modern information and sensor technologies the possibilities for their cost-effective optimisation will emerge (E8) - II./4
- Development of a system to assess food safety based on data on traceability which would include a database with examples of positive and negative past cases and a multi-criteria model to assess the selected properties of a product. The effects of such system are multifaceted since by using the existing data on traceability the system can operate significantly faster and the costs of security assessment can be decreased, number of expensive laboratory analyses reduced, while at the same time the data and knowledge can be accumulated to assess food products. (E8) - II./4
- Development of the strategy and suitable ICT tools to establish a sustainable use of phytopharmaceutical agents in food processing that will link the information of public data sources and structured expertise by taking into account agricultural products, social and environmental criteria to provide a sustainable FFS use in Slovenia. (E8) - II./4



Left: Seven communities in the analysed "retweet" network of environmental tweets: sceptics form a community which is separated from the rest of the network.

Bottom left: A graphical user interface of a web system to support decision-making in the field of agriculture which has been developed for a client from France. It is designed on the basis of a multi-platform infrastructure which provides scalability and fault tolerance. The tool leads users through the entire process of supporting the decision-making which includes quasi ex-post risk analysis and assessment of the initial status of the field, and provides advice for further developments through detailed analysis and visualisation.

Bottom: Interactive system to evaluate scenarios of electricity production in Slovenia.



// Department of Intelligent Systems (E9)

The principal goals of the Department of Intelligent Systems are to study new methods and techniques for intelligent computer systems, their use in the field of intelligent information services, data analysis, intelligent web search, support to decision-making, intelligent agents, and speech and language technologies, intelligent home, intelligent production and economy.

The Department comprises four groups: ambient intelligence, computational intelligence, agent and multi-agent systems, and speech and language technologies.

The research field of ambient intelligence introduces technology into the human environment in a user-friendly and simple way, e.g. in e-health where we develop an application to assist patients with heart failure to control the disease: it will accompany them in the form of sensor wristband and advice them on physical activity, diet, etc.

Computational intelligence focuses on stochastic methods of search, optimisation and learning inspired by biological and physical systems. The methods are transferred into practice, in particular in the field of optimisation of production processes, where, inter alia, we have developed an embedded computer system for quality control in manufacturing together with the Kolektor Group company and international partners.

In the field of agent and multi-agent systems, the research mostly focuses on the development of intelligent autonomous system for managing smart cities and smart homes and intelligent systems to support learning and preserving the cultural heritage, and we have also managed to develop a platform to monitor and manage key city sub-systems (e.g. electrical consumption).

In the field of speech and language technologies, the Department deals with the synthesis of Slovenian speech, text semantics and answering questions. In collaboration with Alpineon and Amebis, a quality Slovenian speech synthesiser was developed, i.e. eBralec (e-Reader) (http://ebralec.si/). Speech intelligibility and the natural aspect of artificially generated speech were significantly improved.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Agriculture and hunting, forestry, fishing, mining, processing activities, electric power, gas and steam supply, water supply, sewerage and waste management, environmental remediation, civil engineering, trade, maintenance and repair of motor vehicles, traffic and storage, hospitality, information and communication activities, financial and insurance activities, real estate business, professional, scientific and technical activities, administrative and support service activities, activities of public administration and defence, activities of compulsory social security, education, health care and social security, cultural, entertainment and leisure activities, other activities.

OFFER FOR INDUSTRY:

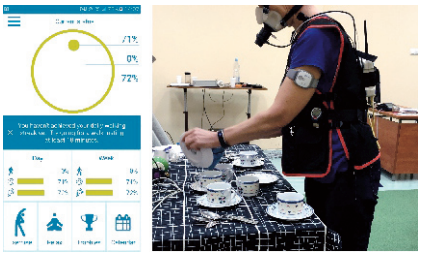
- 3D-visualisation of rooms – 3D virtual interactive presentation of the main IJS building
- Analysis of gaming
- Autonomous driving – Multi-objective optimisation algorithm for discovering driving
- Home e-Doctor – System for diagnosing home diseases by using a mobile phone.
- eBralec Android – Slovenian speech synthesiser for different environments (Android/MS Speech API compatible)
- e-Gibalec – Application for improving physical activity of schoolchildren. The application is designed as a game where children challenge themselves in physical activity. The application has an integrated algorithm to change physical activity adapted to a target age group.
- Electronic and mobile health care – Development of several prototypes based on modern technologies (ICT) with the aim to improve security and safety of health, elderly chronic patients and people with disabilities.
- e-turist – Smart personal mobile tourist guide
- Evolutionary computation
- e-Vratar – Intelligent doorman for home surveillance. It operates on Android devices.
- Inductive logic programming
- Intelligent agent and multi-agent systems
- Intelligent, virtual assistants – Intelligent Assistant is an interface which helps users to gain information It understands questions in a natural language and tries to provide the best answer to users.
- Intelligent home – Development of a technology to manage home based on artificial intelligence which will automatically learn from the user's habits.
- Cultural attractions – System for virtual tours of cultural attractions within museums. A prototype includes a recommendation system which provides a custom-made display of a selection of works of art.
- Control of the quality of products with smart cameras – Embedded computer system to control the quality of products in a production process based on camera images and predictive models designed through machine learning.
- Prediction of faults or service of refrigeration device – A program analyses the operation of devices, in particular refrigeration devices, and predicts service time or warns about an imminent problem.
- Prediction of hospitalisations – The model uses telemonitoring data to predict future hospitalisations in patients with heart disorders.
- Ontologies and semantic web
- OpUS – optimisation of smart buildings – Optimisation of smart building management. By using sliders, users set their preferences. The system learns the user's habits. A multi-objective optimisation arranges processes in a building.
- Smart watch for the old people (Assistance for the people over 65 – falls) - Within the H2020 InLife project, a smart watch was designed which autonomously detects falls. It is equipped with an SOS button, provides communication with caregivers, settings, reminders, determines location – 10 functions in total.
- Smart city – A prototype of the smart city platform which provides integration and management of various city sub-systems. The platform includes advanced

algorithms to manage and optimise city resources.
- Platform for sound analysis – The platform for sound analysis provides filtering, segmentation and extracting individual sound features, design of machine learning models and model assessment.
- Principles of intelligence and cognitive sciences
- Computerised restoration of wall paintings and support for their composition
- Web data mining
- Speech synthesis
- Synthesis of knowledge for system modelling and management
- System for analysing entries and exits to/from premises and buildings and detecting unusual events
- System for the control of product quality in a production process based on machine vision and machine learning
- Systems to support decision-making
- Monitoring of activities – Algorithm for recognising activities and assessing the consumption of human energy. The developed algorithm uses sensor data of a smart phone, wristband or ECG of chest belt with an integrated accelerometer.
- Monitoring of diabetes – Algorithm for forecasting and recognising hyperglycaemia and hypoglycaemia from ECG signal, breathing and movement
- Monitoring of environmental parameters in the office/at home – Monitoring of environmental parameters and recognising uncomfortable features and recommending measures to improve the quality of environment.
- Tourist information system – Platform for: intelligent travel planning, communication between tourists and tourist information providers and integration of tourist site providers.
- TV for municipalities – Provides the operation of web television to municipalities or institutions
- Detection of heart failures – Algorithm for detecting heart failures. The algorithm uses the sound from a digital stethoscope or a mobile phone.
- Detection of stress – Algorithm for detecting stress based on a wristband and mobile phone.
- Artificial intelligence in medicine
- Safety smart watch – Within the H2020 InLife project, a smart watch was designed which detects falls and has 10 functions. The redesigned watch for safety continuously monitors the user and informs you if anything goes wrong.
- Multi-objective optimisation for engineering design, production processes and energy efficiency
- Multi-objective optimisation algorithm for discovering driving strategies
- Multi-strategy learning and principles of multiple knowledge

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Stress detection (E9) III./7
- Other applications of E9 prototypes (E9) I./1
- eTurist (E9) II./5
- eVratar (E9) I./2
- Designing models by using laboratory equipment for precise determination of human parameters in movement (E9) III./7
- Intelligent systems for the automotive industry – Intelligent Car/Caravan (E9) III./8

- Engineering design, optimisation of production processes, energy efficiency (E9) III./6
- Implementation of industrial research in the field of recommendation systems to order goods from a warehouse or store, and user profiling (E9) I./1
- Implementation of a study entitled: Bar positioning (E9) I./1
- Possibility of optimising melt flow simulations (E9) III./6
- Quality control in production (E9) III./6
- Optimisation of driving and transport (E9) III./8
- Optimisation of plastic injection model (E9) III./6
- Optimisation of the management of energy-efficient smart buildings (E9) II./2
- Smart buildings (E9) I./2
- Checking the entries of premises (E9) I./2
- Prototype of the GOVOREC speech synthesis application (E9) III./7
- Research into the intelligent home (E9) II./2
- Development of an intelligent system for reviewing the status of sources and equipment and their management (E9) - I./1
- Development of an optimisation system for designing construction elements (E9) - II./2
- Restoration and presentation of wall paintings (E9) II./5
- Simulation and optimisation of casting, rolling and heat treatment for competitive production of top-class steels (E9) III./6
- Co-development of Virtual Assistant (E9) I./1
- Stochastic optimisation / New products and solutions for further optimisation of networks and consequently better energy efficiency. (E9) I./2



Fit4Work application helping older workers to relax, maintain good fitness and have quality working environment (left) and measurements of human energy consumption needed to develop the application (right).

The Department of Intelligent Systems provides IT support to optimise steel production in the Štore Steel steelworks.

// Biochemistry, molecular and structural biology (B1)

Researchers study the properties of proteases and their inhibitors, and mechanisms of processes leading to a programmed cellular death and regulating the immune response of an organism. One of the important fields is also the knowledge and understanding of three-dimensional structure of macromolecules and their complexes at the atomic level, i.e. a link between amino acid sequence and molecule operation mechanism.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Medicine, pharmaceutical industry

OFFER FOR INDUSTRY:

- Diagnostic and in vivo imaging of laboratory animals (fluorescence, bioluminescence and μCT)
- Nanodelivery systems for targeted delivery of substances
- Proteomic laboratory
- The role of proteases in different pathologic processes (in cancer, rheumatoid arthritis and osteoarthritis and various neurodegenerative diseases)

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Performance of mass stereoscopic analysis (B1) - III./7
- Nanodelivery systems and antimicrobe factors on the molecule surfaces (B1) - III./7

// Molecular and biomedical sciences (B2)

The Department focuses on fundamental research in the field of protein biochemistry, molecular and cell biology and genetics with the purpose of acquiring new knowledge in the field of human and animal pathophysiology to improve human and animal health.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

Medicine, pharmaceutical industry

OFFER FOR INDUSTRY:

- Genomics of yeast
- Lipid metabolism related to cancer
- Toxins in snake venom

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Yeast-based cell factories for production of green chemicals, studying of the metabolism of fats in yeast (B2) - III./7

// Biotechnology (B3)

Researchers study biological molecules of microbiological, fungal, plant and animal origin to be used in human and veterinary medicine for protection of plants, preparation of quality and safe food and environmental protection.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

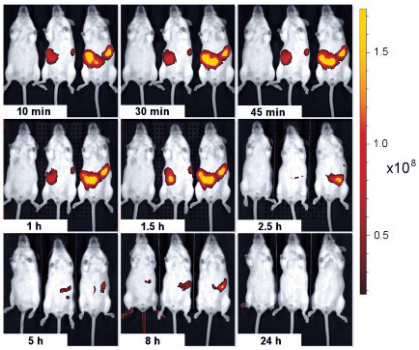
Veterinary medicine, medicine, ecology

OFFER FOR INDUSTRY:

- Lectins for diagnostics and therapy of various types of cancer and infectious diseases
- Nitroxoline and derivatives as new antitumour agents
- Post-transcriptional regulation networks in neurodegenerative diseases
- Recombinant probiotic lactic-acid bacteria for treating inflammatory bowel syndromes

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

- Application of systems for automation of laboratory processes to other levels (e.g. protein classification) (B3) - I./1 and III./7
- New approaches to analytics, diagnostics and treatment by using glycobiology, lactic-acid bacteria and RNA (B3) - II./4 and III./7



Representative example of 24h-visualisation of mice to which no bacteria (left, control) or 2.5x10 to the power of 10 of L. lactis bacteria (right) expressing IRFP713 were applied. Colour scale indicates radiant efficiency.

3D-structure of human cystatin F with orange-marked mutations.

// Department of Reactor Engineering (R4)

The Department focuses on research targeting the development and use of advanced models and computer simulation tools that provide forecasting and understanding physical processes which are important for the safety of nuclear power plants. Interdisciplinary research interlinks thermo-hydraulic, strength and probabilistic safety analyses and are also applicable in the wider field of energetics and energy technologies.

SUITABLE FOR THE FOLLOWING INDUSTRIES:

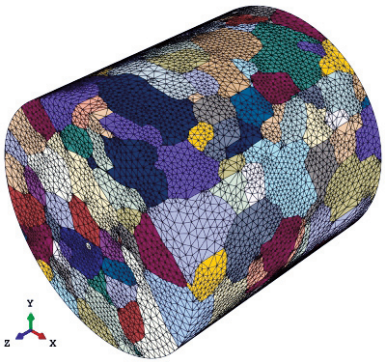
Production of machinery, mechanical engineering and maintenance, automotive industry, process chemistry industry, electric works, energetics, traffic, civil engineering

OFFER FOR INDUSTRY:

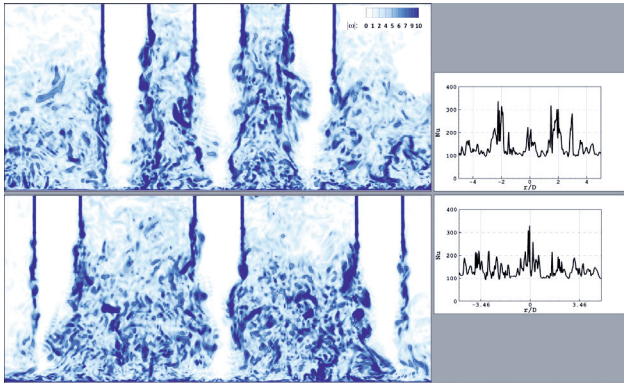
- Simulations of developing inter-crystal cracks in stainless steel
- Thermo-hydrodynamics (dynamics of single- and multiphase fluids, heat and mass transfer – hydraulic analysis)
- Solid mechanics (deterministic strength analysis, ageing and integrity for safety of important components)
- Reliability, industrial hazard and risk (analysis of risk and uncertainty, probabilistic safety analyses)

EXAMPLES OF COLLABORATION WITH THE PRIVATE SECTOR:

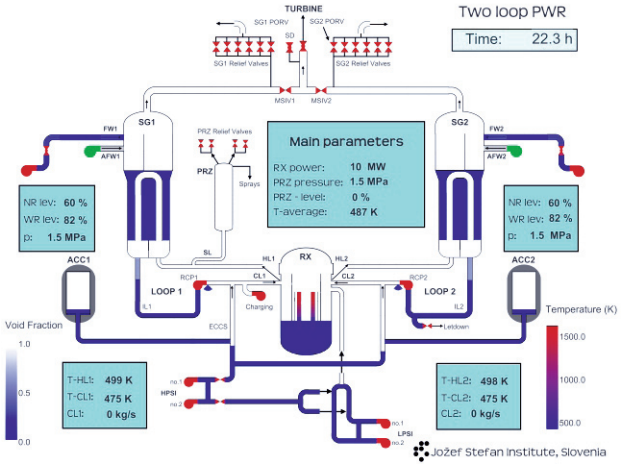
- Numeric simulations, 2D/3D simulation of mechanical response (MKE) (R4) III./6 and III./9
- Numeric simulations, 2D/3D simulation of fluid flow (CFD) (R4) III./6 and III./9



Ageing and integrity for safety of important components: Numerical methods are used to forecast the occurrence and development of cracks by taking into account the shapes and directions of crystal grains. The figure shows the model of a wire made of stainless steel. Colours indicate individual crystal grains.



Methods for efficient heat transfer: A numeric simulation of cooling the surface with turbulent jets is shown; vortex structures (left) and local coefficients of heat transfer between the fluid and cooled panel (right).



Thermo-hydraulic safety analyses: Simulation of a transient event in the Krško Nuclear Power Plant using the RELAP5 program.

// Index according to Strategic Research Innovation Partnerships

I. Digital	II. Circular	III. (S)Industry 4.0
1. Smart cities and communities	3. Networks for the transition to a circular economy	6. Factories of the future
2. Smart buildings and home with wood chain	4. Sustainable food	7. Health – medicine
	5. Sustainable tourism	8. Mobility
		9. Materials as products

// I. Digital

1. Smart cities and communities

- Algorithm for forecasting the room occupancy (E2) - I./1
- Analysis of possibilities to upgrade the A-portal on-line platform (E7) - I./1
- Sample analysis with Mössbauer spectroscopy (and establishing the presence of different oxides (F2) - I./1
- Analyses of small molecules (e.g. metabolites) using the Mikro-PIXE device (F2) - I./1
- Analyses of the 1 ppm level sensitivity in a cubic micrometre of material and at the micron level (PIXE, RBS, ERDA (F2) - I./1
- Bistable switches (E6) - I./1
- Detector for counting nanoparticles in the air (F5) - I./1 and III./7
- Other applications of E9 prototypes (E9) I./1
- Electrocaloric materials and elements for refrigeration devices (K5) - I./1 and I./2
- Industrialisation of innovations (E6) - I./1 and III./6
- Drawing up of the study "Analysing the prevention of glaze-ice formation through operational measures" (E6) - I./1
- Implementation of the project "Dynamic assessment of thermal conditions of power line cables in glaze-ice conditions" (E6) - I./1
- Implementation of industrial research in the field of recommendation systems to order goods from a warehouse or store, and user profiling (E9) I./1
- Implementation of a study entitled: Bar positioning (E9) I./1
- Quality of urban living (O2) - I./1
- Communication systems, design, production, tests of small series of electronic assemblies (E6) - I./1

- Method and capacitance sensor for counting aerosol nanoparticles (F5) - I./1 and III./7
- Module for exporting reports related to the MobECG application (E6) - I./1
- Control and management of processes and logistics and optimisation of processes and systems (E7) - III./6 and I./1
- Nanosensors for humidity, Co2/O2, formaldehyde (K7) - I./1 and III./9
- Advanced techniques of ray tracing to characterise radio signals (E6) - I./1
- Cooling of overhead line conductors in horizontal wind speed below 0.6m/s (E6) - I. 1
- Optimisation of system operation in the field of environment (E2) - I./1
- Optimisation of channels for DMR networks in the 146–174 MHz frequency range (E6) - I./1
- Optimisation of packaging, loading and transport of elements of prefabs (E7) - I./1 and III./6
- Optimisation of production/sale – dynamic (prompt) responding to changes of orders (E7) I./1 and III./6
- Optimisation of the polymerisation process (E2) - I./1
- Optimisation of the processes in high-shelf warehouses (E2) - I./1
- Optimisation methods – Assistance in simulations and optimisations (MKE) and management of complex problems of signal, procedure, data processing – datamining, etc. (E7) - I./1 and III./6
- Smart systems for environmental and resource management (F7) I./1 and II./3
- The Vesna platform and sensors for changing air quality (E6) - I./1 and II./3
- The field of application-specific sensors and actuators, integration of various sensors, actuators and other microsystems (K5) - I./1 , I./2, III./6, III./7 , III./8
- Installation of networks for pollution monitoring (E6) - I./1 and II./3
- Movable entrance platform – application with magnets (K7) - I./1 and I./2
- Radiation resistant light (F8) - I./1 and 2 and III./9
- Research of reliability of connections in HDI circuits (F9) - I./1 and III./6
- Development of digital pulse processor (F2) - I./1
- Development and implementation of algorithms for scalable analysis of data streams (E3) - I./1
- Development of innovative systems for medicine delivery (K9) - I./1 and III./7
- Development of an intelligent system for reviewing the status of sources and equipment and their management (E9) - I./1
- Development of the module for heating up fuel cell stacks (E2) - I./1
- Research and development in the field of direct-drive electric powertrain (F9) - I./1 and III./8
- Pressure sensors (and other sensors) for air-conditioners (K5) - I./1 and I./2
- Sensors for analysing water in a washing machine (E6) - I./1
- Signal safety device as per SIL4 standard (E7) - I./1 and III./8
- Co-development of Virtual Assistant (E9) I./1
- Study on the challenges of the Internet of the future (E5) - I./1
- Study of propagation and topologies for wireless sensor networks in non-licensed frequency bands (E6) - I./1
- Technology for implementing an intelligent mobile home of the next generation (E6) - I./1
- Toshl: providing information on the cheapest products according to stores. (E7) - I./1
- Artificial intelligence and applications in health care (E3) - I./1 and III./7
- Security, privacy and reliability of information networks – Smart Grids (E5) - I./1
- Verification of the antennae tracing system simulator (E6) - I./1
- Protective housing of the ICT hub resistant to EM radiation and EM tapping (E7) - I./1 and III./6

2. Smart buildings and home with wood chain

- Application for easy control of heating system operation and costs (E7) - I./2
- Electrocaloric materials and elements for refrigeration devices (K5) - I./1 and I./2
- eVratar (E9) I./2
- Interactive facade: Use of a coating made of liquid crystal (F5) - I./2, III./6 and III./9
- Designing tools and procedures for participatory detection of needs of citizens using smart/mobile tools and applications. This segment also includes the analysis of digital footprints (social networks, web forums, etc.) by using "big data" analysis and concepts to analyse behavioural patterns and detection of perception of citizens. (E8) - I./2
- Advanced living environment (O2) - I./2
- Optimisation/minimisation of the number/form of facade elements (E7) - III./6 and I./2
- Smart buildings (cogeneration, energy stations) (E2) - I./2
- Smart buildings (E9) I./2
- Smart coatings and surfaces for civil engineering, medicine, etc. (F7) - I./2, III./7 and III./9
- The field of application-specific sensors and actuators, integration of various sensors, actuators and other microsystems (K5) - I./1, I./2, III./6, III./7, III./8
- Surface coatings – defining the properties of elements and possibilities of collaboration in the field of vacuum thermal insulation (F5) - I./2 and III./9
- Movable entrance platform – application with magnets (K7) - I./1 and I./2
- Checking the entries of premises (E9) I./2
- Development of analytical tools (machine learning, datamining) for data from sensor systems to capture physiochemical environmental parameters affecting the health and well-being (E8) - I./2
- Development of methods and tools for data analysis, predictive modelling, datamining and support to decision-making and their use in the field of transport and energetics. (E8) - I./2
- Pressure sensors (and other sensors) for air-conditioners (K5) - I./1 and I./2
- Stochastic optimisation / New products and solutions for further optimisation of networks and consequently better energy efficiency. (E9) I./2

// II. Circular

3. Networks for the transition to a circular economy

- Analysis of minerals, extracts and residue after processing (O2) - II./3
- Analysis of water, ground, earths: organic (natural substances, persistent pollutants, medicinal substances and their products of transformation), inorganic (elements, speciation), isotopic (O2) - II./3
- Elementary and isotopic analysis of foodstuffs and food supplements and their individual components to determine the authenticity and geographical origin (O2) - II./3
- Integrated methodology for remediation of environment burdened with past industrial activities (O2) - II./3

- Implementation of advisory activity in the field of assessing environmental impacts and providing production safety (O2) - II./3
- Characterisation of alloys (O2) - II./3
- Chemical characterisation of waste (sediments, technological sludge, industrial and municipal wastewater) as a raw material input and during the processing to the end product (O2) - II./3
- Sustainable competitive productions – EU projects - II./3 and III./6
- Microreactors based on titanium oxide (K7) - II./3
- Nanomaterials as a support for ecotechnological optimisation (F5) - II./3 and III./6 and III./9
- Data processing and development of waster water treatment technologies (K1) - II./3
- Optimising remediation of landfill sites for materials contaminated with polychlorinated biphenyls (K1) - II./3
- Smart systems for environmental and resource management (F7) I./1 and II./3
- The Vesna platform and sensors for changing air quality (E6) - I./1 and II./3
- Installation of networks for pollution monitoring (E6) - I./1 and II./3
- To increase the use of alternative energy sources, the so-called smart power grid must be constructed. An important element of the respective grid is the ability to foresee and forecast the production of individual power plants as well as the requirements of network transmission capacities and the needs of end-users. This type of forecast can be efficiently implemented by using methods and approaches of datamining and machine learning. (E8) II./3
- Processing of waste products from the food industry into new products with high added value (O2) - II./3
- Prevention of major accidents with dangerous substances (obligation laid down by the legislation) (K1) - II./3
- Nanocarbon project (K8) - II./3
- Development of photocatalytic superparamagnetic nanocomposites for the emission reduction procedures (K8) - II./3
- Development of key components of new "high efficiency" generation of environmentally friendly alternators (E7) - III./6 and II./3
- Development of technologies for managing process and waste water (K1) - II./3
- Segments of environmental permits such as simulations of chlorine cloud movements in the event of accident (K1) - II./3
- System for mobile monitoring of vital physiologic parameters and environment context (E6) - II./3
- Management strategy related to irradiated nuclear fuel in the Republic of Slovenia (F8) - II./3
- Heat converter -> Optimisation related to diffusion of cooper into steel / heat converters without copper for applications used to extract potable water (K7) - II./3 and III./9
- Use of new materials made of recycled and industrial waste raw materials (O2) - II./3

4. Sustainable food

- Approaches to analytics, diagnostics and treatment by using glycobiology, lactic-acid bacteria and RNA (B3) - II./4 and III./7
- Food processing procedures (F5) - II./4
- Development of the system to analyse consumer wishes, needs and behaviour, and

promote participation in designing new products. Knowing consumer wishes, needs and behaviour is crucial in providing economic performance of food producing and processing companies. This dedicated research is very complex and expensive. However, a similar type of research may be conducted at a significantly lower price by using modern information technologies for web mining and sentiment analysis. (E8) - II./4

- Development of the system for analysing, modelling and smart designing of production and food-processing processes. To a large extent, the efficiency of food production and processing depends on the efficiency of production and processing processes applied and by developing modern information and sensor technologies the possibilities for their cost-effective optimisation will emerge (E8) - II./4
- Development of a system to assess food safety based on data on traceability which would include a database with examples of positive and negative past cases and a multi-criteria model to assess the selected properties of a product. The effects of such system are multifaceted since by using the existing data on traceability the system can operate significantly faster and the costs of security assessment can be decreased, number of expensive laboratory analyses reduced, while at the same time the data and knowledge can be accumulated to assess food products. (E8) - II./4
- Development of the strategy and suitable ICT tools to establish a sustainable use of phytopharmaceutical agents in food processing that will link the information of public data sources and structured expertise by taking into account agricultural products, social and environmental criteria to provide a sustainable FFS use in Slovenia. (E8) - II./4

5. Sustainable tourism

- eTurist (E9) II./5
- Restoration and presentation of murals (E9) II./5

// III. (S)Industry 4.0

6. Factories of the future

- Adaptive automation (E1) - III./6
- Aerodynamic geometrical optimisation of a suction unit propeller (E7) - III./6
- Analysis of production processes and design of automation in the lighting equipment production in the glass factory (E1) - III./6
- Automation (E1) - III./6
- Automation and robotisation of production (E1) - III./6
- Automation and robotisation in civil engineering (E1) - III./6
- Design of a heat exchanger between a heating medium and heated water (E7) - III./6
- Supplement and change of control and operation system for a production line (E1) - III./6
- Photonics technologies (F5) – III./6
- Refrigeration systems based on the magnetocaloric effect (K7) - III./6
- Industrialisation of innovations (E6) - I./1 and III./6
- Interactive facade: Use of a coating made of liquid crystal (F5) - I./2, III./6 and III./9
- Engineering design, optimisation of production processes, energy efficiency (E9) III./6

- Production of electric motors (E1) - III./6
- Production of specifications and designing solutions for a new system of automated preparation, control and operation (E1)
- Construction of industrial platform for an optimal placement of an industrial lighting system in facilities (E7) - III./6
- Implementation of a pilot model to optimise design and termination of cooktop production (E7) - III./6
- Ceramic and functional materials within the scope of the modern manufacturing technology for materials (K5) - III./6
- Components for industry and medicine (F7) - III./6 and III./7
- Sustainable competitive productions – EU projects - II./3 and III./6
- Quality control with machine vision (E7) - III./6
- Control of core installation in a closed mould (E7) - III./6
- Low-power miniaturised contactless BIOimpedance Measurement Device - BIOMeD (E7) - III./6
- Materials for energy conversion (K9) - III./6 and III./9
- Measurement of suitability of a mould in terms of its grey and nodular cast (E7) III./6
- Method of final elements to optimise the procedure of modelling the drawing process (E6) - III./6
- Modelling, simulation and optimisation of production processes (E7) - III./6
- Possibility of optimising melt flow simulations (E9) III./6
- Control and management of processes and logistics and optimisation of processes and systems (E7) - III./6 and I./1
- Quality control in production (E9) III./6
- Nanomaterials as a support for ecotechnological optimisation (F5) - II./3 and III./6 and III./9
- Nanotechnologies (F5) - III./6
- Numeric simulations, 2D/3D simulation of mechanical response (MKE) (R4) III./6 and III./9
- Numeric simulations, 2D/3D simulation of fluid flow (CFD) (R4) III./6 and III./9
- Assessment of panels in terms of their suitability of use (E7) - III./6
- Optimisation of the level of availability of the whole heterogeneous and complex production system (E7) - III./6
- Optimisation of absorbent composite materials (E7) - III./6
- Optimisation of plastic injection model (E9) III./6
- Optimisation of distribution and search for optimum composite material for protection against EMC (E7) - III./6 and III./9
- Optimisation of distribution and search for optimum composite material for protection against EMC (E7) - III./6
- Optimisation of the construction of high-shelf warehouses (E7) - III./6
- Optimisation of electric motor clutch plates (E7) - III./6
- Optimisation of packaging, loading and transport of elements of prefabs (E7) - I./1 and III./6
- Optimisation of designing the production process (E7) - III./6
- Optimisation of production/sale - dynamic (prompt) responding to changes of orders (E7) I./1 and III./6
- Optimisation of production procedure for the preparation of PTC resistors (K8) - III./6
- Optimisation/minimisation of the number/form of facade elements (E7) - III./6 and I./2
- Optimisation methods – Assistance in simulations and optimisations (MKE) and management of complex problems of signal, process, data processing –

datamining, etc. (E7) - I./1 and III./6
- Smart factories (E1) - III./6
- Smart sensors and nanosensor structures for industrial, biomedicine and environmental applications (F7) - III./6
- The field of application-specific sensors and actuators, integration of various sensors, actuators and other microsystems (K5) - I./1 , I./2, III./6, III./7 , III./8
- Transfer of rotation --> translation movements (E1) - III./6
- Optimisation processes: Optimisation of production (E2) - III./6
- Research of reliability of connections in HDI circuits (F9) - I./1 and III./6
- Development and construction of a simulator for a refrigeration device (3P) (E7) - III./6
- Development of an intelligent system for reviewing the status of sources and equipment and their management (E7) - III./6
- Development of key components of new "high efficiency" generation of environmentally friendly alternators (E7) - III./6 and II./3
- Development of a device for automated preblowing of glass products (E1) - III./6
- Development of an optimisation system for designing construction elements (E7) - III./6
- Reconfigurable and modular robot-based service and assembly (E1) - III./6
- Self-repairing circuits (E7) - III./
- Relocation of the control and operation system into a new factory (E1) - III./6
- Sensors (F5) - III./6
- Simulation and optimisation of casting, rolling and thermal processing for a competitive production of top-class steels (E9) III./6
- Simulations of product design (E7) - III./6
- System for the automated integrated simultaneous production of various products (E1) - III./6
- Spectrometer for automated characterisation of new compounds with the 14N method of nuclear quadrupole resonance (F5) - III./6 and III./9
- Machine vision: identification of errors in rubber products (E7) - III./6
- Tests in electronics (E7) - III./6
- Factories of the future (E1) - III./6
- Sustainable production – EU projects - III./6
- Use of new technologies to prevent encrustation on industrial systems (K7) - III./6
- Use of rare earths alloys and transition metals for high-energy permanent magnets and batteries based on metal hybrid (K7) - III./6
- Design of the model for forecasting a service life of bearings of a vacuum cleaner compressor motor (E7) III./6
- Protective housing of the ICT hub resistant to EM radiation and EM tapping (E7) - I./1 and III./6

7. Health – medicine

- Analyses on the Raman microscope (K1) - III./7
- Application of systems for automation of laboratory processes to other levels (e.g. protein classification) (B3) - I./1 and III./7
- Stress detection (E9) III./7
- Detector for counting nanoparticles in the air (F5) - I./1 and III./7

- Designing models by using laboratory equipment for precise determination of human parameters in movement (E9) - III./7
- Improvement of technological processes: use of magnetic particles for the immobilisation of catalysts and enzymes, magnetic separation of target molecules/microorganisms from mixtures (K8) - III./7
- Performance of mass stereoscopic analysis (B1) - III./7
- Conducting personal dosimetry (F2) - III./7
- Components for industry and medicine (F7) - III./6 and III./7
- Method and capacitance sensor for counting aerosol nanoparticles (F5) - I./1 and III./7
- Possibility of cooperating with the parent organisation in developing and replacing existing functional groups of medicines – related to the pentafluoro sulfanyl group - SF5 (K1) - III./7
- Yeast-based cell factories for production of green chemicals, studying of the metabolism of fats in yeast (B2) - III./7
- Nanoparticles as a contrast agent for NMR (K8) - III./7
- Nanodelivery systems and antimicrobe factors on the molecule surfaces (B1) - III./7
- Nanostructures for magnetic delivery of medicinal substances (K8) - III./7
- Smart coatings and surfaces for civil engineering, medicine, etc. (F7) - I./2, III./7 and III./9
- The field of application-specific sensors and actuators, integration of various sensors, actuators and other microsystems (K5) - I./1 , I./2, III./6, III./7 , III./8
- Verifying the position of radioactive sources during tumour brachytherapy (F9) - III./7
- Approaches to analytics, diagnostics and treatment by using glycobiology, lactic-acid bacteria and RNA (B3) - II./4 and III./7
- Prototype of the GOVOREC speech synthesis application (E9) III./7
- Development of innovative systems for medicine delivery (K9) - I./1 and III./7
- Development of semi-conductive detectors to be used in medicine and high radiation fields (F9) - III./7
- Collaboration in developing magnetic nanoparticles for the introduction of heritable material in cells (K8) - III./7
- Theranostic systems for cancer treatment based on hybrid nanoparticles (K7) - III./7
- Therapeutic, diagnostic and theranostic technologies and products (F5) - III./7
- Artificial intelligence and applications in health care (E3) - I./1 and III./7
- Multi-functional body sensor (E6) - III./7

8. Mobility

- Intelligent systems for the automotive industry – Intelligent Car/Caravan (E9) III./8
- Multipole NdFeB plastomagnet for rotor application (K7) - III./8 and III./9
- Optimisation of driving and transport (E9) - III./8
- The field of application-specific sensors and actuators, integration of various sensors, actuators and other microsystems (K5) - I./1 , I./2, III./6, III./7 , III./8
- Signal safety device as per SIL4 standard (E7) - I./1 and III./8
- Highly coercive ND-Fe-B plastic neodymium magnets for automotive applications (K7) - III./8 and III./9

9. Materials as products

- Analysis of magnets (K7) - III./9
- Analysis of CC Master Pe90270 and Floka white 8000 samples (F5) - III./9
- Anti-corrosion coatings (for 1. starters, 2. magnets) (K3) - III./9
- Contactless and contact topographic analysis: roughness, form, statistics of defects, 3D-view (F3) - III./9
- Determination of the content of metals in artificial resins or coatings (K7) - III./9
- Electrical characterisation of material, microstructural analysis (K9) - III./9
- Hydrophobic, self-cleaning, thermoinsulative coatings and suspensions (K9) - III./9
- Homogeneity of materials / CRM (K1) - III./9
- Interactive facade: Use of a coating made of liquid crystal (F5) - I./2, III./6 and III./9
- Interpretation of damage causes (F3) - III./9
- Searching for alternatives to passivation procedures (K3) - III./9
- Cutting of a small sample from a tool and subsequent preparation of metallographic specimen (F3) - III./9
- Chemical and morphological analysis of surface cross-sections (K7) - III./9
- Ceramic coatings (K7) - III./9
- Ceramic materials in the field of multi-component smart materials (K5) - III./9
- Literature research of the use of coatings for comparable applications (F3) - III./9
- Magnets without rare earths (K7) - III./9
- Magnets of new generation – high-temperature NdFeB magnets (K7) - III./9
- Materials and technologies for the use of thick layer varistors and oxide thermoelectrics based on ZnO (K7) - III./9
- Measurement of coating adhesion (F3) - III./9
- Measurement of friction coefficient (F3) - III./9
- Measurement of hardness on macro-, micro- and nanoscale; on surface or in cross-section (F3) - III./9
- Multipole NdFeB plastomagnet for rotor application (K7) - III./8 and III./9
- Application of standard coatings for cut tools (TiN, TiAlN) (F3) - III./9
- Application of advanced coating for cut tools (AlTiN nanofilm, TiAlSiN nanocomposite) (F3) - III./9
- Application of coatings on redesigned tools (punching machines, bending blades, punches) (F3) - III./9
- Application of CrN coating on tools for the food and pharmaceutical industries - (F3) - III./9
- Application of self-lubricating aCN coating on tools where reduced friction coefficient is needed (F3) - III./9
- Nanosensors for humidity, Co2/O2, formaldehyde (K7) - I./1 and III./9
- Flame-retardant polymer foams/coatings (K7) - III./9
- Non-invasive analysis of large sample (up to 3 kg): optical microscopy and contact profilometry (F3)- III./9
- Low doped ZnO ceramics for energy varistors (K7) - III./9
- Materials for energy conversion (K9) - III./6 and III./9
- Nanomaterials as a support for ecotechnological optimisation (F5) - II./3 and III./6 and III./9
- Numeric simulations, 2D/3D simulation of mechanical response (MKE) (R4) III./6 and III./9
- Numeric simulations, 2D/3D simulation of fluid flow (CFD) (R4) III./6 and III./9
- Optical microscopy of surface and cross-section (F3)- III./9

- Optimisation of distribution and search for optimum composite material for protection against EMC (E7) - III./6 and III./9
- Optimisation in the stator production line: solutions extending the service life of an electrode (K3) - III./9
- Smart coatings and surfaces for civil engineering, medicine, etc. (F7) - I./2, III./7 and III./9
- Increasing the hardness of non-corrodible sheet metal with material thickness of 0.6 or 0.5mm (K3) - III./9
- Frame surface protection (K3) - III./9
- Surface coatings – defining the properties of elements and possibilities of collaboration in the field of vacuum thermal insulation (F5) - I./2 and III./9
- Coatings for increasing the service life of rotors in coolants (K3) - III./9
- Prevention of calcination with new materials, coatings (K7) - III./9
- Coatings and layers (K7) - III./9
- Comparative analysis of good piece : poor piece (F3) - III./9
- Comparative analysis of the applicability of different coatings on the same type of tool (F3) - III./9
- Comparison of previous cases of applying coatings on similar tools (F3) - III./9
- Radiation resistant light (F8) - I./1 and 2 and III./9
- Development and characterisation of mineral fibres (K9) - III./9
- Developing a combination of standard customised coatings (F3) - III./9
- Development of microwave ferrites (K9) - III./9
- Developing a modification of one of standard customised coatings (F3) - III./9
- Developing a completely new coating for the client (F3) - III./9
- Development of PTC ceramics for applying electrodes through sputtering (K9) III./9
- Self-cleaning antibacterial photocatalytic coatings in household appliances (K9) - III./9
- Synthesis of magnet nanoparticles (K9) - III./9
- Spectrometer for automated characterisation of new compounds with the 14N method of nuclear quadrupole resonance (F5) - III./6 and III./9
- Providing advice regarding suitable protection technology (F3) - III./9
- Heat converter -> Optimisation related to diffusion of cooper into steel / heat converters without copper for applications used to extract potable water (K7) - II./3 and III./9
- Highly coercive ND-Fe-B plastic neodymium magnets for automotive applications (K7) - III./8 and III./9
- Scanning electron microscopy of the surface and cross-section; local analysis of chemical composition also included (F3) - III./9
- Protected permanent magnets for advanced applications at high temperatures (K7) - III./9

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