The Jožef Stefan Institute in 2023

JSI in numbers • Scientific Excellence • Awards and Recognitions • Visits • Science and Art • JSI for Society

The institute in numbers

5
locations

1,218
employees*

831
researchers*

799
young researchers***

244
faculty members lecturing at ->

49
various higher-education institutions**

*Data collected on 31.12.2023
**Data are for 2023
***Data for 2000-2023

Staff

1,218

Number of employees by gender and area of activity

39 % female

61 % male

68 % researcher

33 % 67 %

32 % support staff

53 % 47 %

831 researchers

from **42** different countries

85 % local staff

15 % international staff

Main areas of research

Physics, nuclear engineering and energy

- Theoretical physics
- Low and medium energy physics
- Thin films and surfaces
- Surface technology
- Solid State Physics
- Gas electronics
- Complex matter
- Reactor physics
- Experimental particle physics
- Reactor technology

10 departments

Electronics and Information Technologies

- Automation, biocybernetics and robotics
- Systems and control
- Artificial intelligence
- Open systems and networks
- Communication systems
- Computer systems
- Knowledge technologies
- Intelligent systems

8 departments

Chemistry, biochemistry, materials and environment

- Biochemistry, molecular and structural biology
- Molecular and Biomedical Sciences
- Biotechnology
- Inorganic chemistry and technology
- Physical and organic chemistry
- Electronic ceramics
- Nanostructured materials
- Synthesis of materials
- Advanced materials
- Environmental sciences

10 departments

806

researchers devided by scientific fields
7 female in **18** male researchers are employed in centres and technical services

42 %
researchers are employed at the field of Physics, nuclear engineering and energy

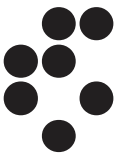
23 % 77 %

24 %
researchers are employed at the field of Electronics and Information Technologies

21 % 79 %

34 %
researchers are employed at the field of Chemistry, biochemistry, materials and environment

54 % 46 %



SCIENTIFIC EXCELLENCE through ERC project

Total
9
ERC projects

2012	**Dragan Mihailović**	(AdG 2012)	**Trajectory**
2017	**Dragan Mihailović**	(PoC 2017)	**Umem4QC**
2019	**Matjaž Humar**	(StG 2019)	**Cell-Lasers**
	Peter Križan	(AdG 2019)	**FAIME**
	Igor Muševič	(AdG 2019)	**LOGOS**
	Matic Lozinšek	(StG 2020)	**HiPeR-F**
2022	**Peter Križan**	(PoC 2022)	**CherPET**
	Zala Lenarčič	(StG 2022)	**DrumS**
2023	**Lev Vidmar**	(CoG 2023)	**Boundary**

In 2023, the seven previous ERC grantees at the Jožef Stefan Institute were joined by Prof. Dr Lev Vidmar, who was awarded an ERC grant to consolidate his position on an independent research path. In his 5-year project entitled The Limits of Quantum Chaos, he will study the formation conditions for a substance that does not have temperature.

In 2007, the European Union established the European Research Council (ERC) as the first European institution to fund cutting-edge frontier research in all scientific fields with no pre-defined priorities. Every year, it selects and funds the most creative researchers, regardless of their nationality or age, to carry out their projects in Europe. It offers four long-term and wel-funded research project schemes:

- the ERC Starting Grant (StG),
- the ERC Consolidator Grant (CoG),
- the ERC grant for established researchers (AdG) and
- the ERC grant for research synergy (Synergy Grant).

With an additional scheme, the Proof of Concept (PoC) Grant, the ERC helps the grantees bridge the gap between frontier research and the early stages of commercialisation or social application.

The Limits of Quantum Chaos, by Lev Vidmar from the Department of Theoretical Physics

Ljubljana, December 2023, source: STA

Prof. Dr Lev Vidmar was awarded a grant to consolidate his independent research career by the European Research Council (ERC) worth €2 million. In his 5-year project, entitled The Limits of Quantum Chaos, he will study the conditions necessary for the formation of a substance that does not have a temperature.

The project will study thermalization and ergodicity, which are the properties of a fundamental principle in nature, that of quantum chaos. These are properties that apply to most systems in nature and are the reason why substances can be attributed to a certain temperature. We regularly encounter them in everyday life, for example, when an ice cube melts in a warm drink or the smell of fragrant perfume spreads throughout a room.

However, some systems may not submit to these fundamental laws and exhibit different qualities that are inconsistent with the principle of chaos. This leads to a transition between two different phases: between the ergodic phase, in which the system thermalizes, and the non-ergodic phase, in which the system does not thermalize, and therefore the temperature cannot be attributed. Or, to put it another way: between the stage where the ice cube in the hot drink melts, and the one in which it would not melt. The first is happening in chaos, and there is no chaos in the second. Between them – that is, on the verge of chaos – we can encounter a completely new series of phase transitions, called a phase transition with an ergodic fracture.

The phase transition is the »holy grail.« The most well-known are certainly water phase transitions, that is the melting of ice or the evaporation of water. The project aims to confirm the existence of a phase

transition that is different from most phase transitions known so far.

According to Vidmar, in addition to theoretical knowledge of the new phase transition, he will also contribute to the development of experiments or so-called quantum simulators. In addition, by identifying common physical mechanisms, it will help to connect different branches of physics that have hitherto used different terminology to describe similar phenomena. On the other hand, the useful value of the new theoretical findings will be testing the experiment itself, which leads to advances and improvements in the field of quantum simulators and quantum computers.

The ideas behind Vidmar's ERC project were considered controversial just four years ago, he explained. Four years ago, he and a group of Slovenian researchers expressed doubts about the hitherto established hypothesis explaining under what conditions chaos breaks occur. Understanding the conditions for breaking chaos and thermalization is currently considered an unresolved issue and represents a continuation of the pioneering work begun in 1958 by Nobel Prize winner in physics Philip W. Anderson.

As Vidmar explained, the response of the scientific community was great, »but for many people, their emotions prevailed over rational responses. It was quite an affair at the time, some researchers were also very angry, and many of these emotions affected me as the lead author of this study. For the first time, I've experienced for myself what it's like to actively undermine your ideas in one way or another.«

Thus, Vidmar understands the assignment of the project as a recognition and a further incentive to swim a little further away from the mainstream of research. »A period of four years is considered a short period in science, and I am impressed by the extent to which we have managed to implement our ideas during this time. That is why I am optimistic about the next five years, when we will be able to continue the work started within this project. At the same time, this project is also proof that the European research community values the plurality of views and encourages the development of ideas that might initially seem to contradict many of the well-established ideas at the time.«

For his 5-year project The Limits of Quantum Chaos he received €2 million. For the Jožef Stefan Institute, this is the seventh ERC research project, and in this call it was the only Slovenian success. The Faculty of Mathematics and Physics of the University of Ljubljana will also participate as a partner institution. The central hypothesis of Vidmar's project is based on two premisses: that the proximity of the phase transition can be detected in a regime that appears deep in the realm of chaos, and that the key properties of the phase transition can be observed as universal properties of quantum dynamics. These premisses provide a new insight into understanding the conditions under which a phase transition will really occur and when it appears merely as a virtual property in small quantum systems. The project also aims to test these predictions on the latest experimental platforms, today called quantum simulators.

SCIENTIFIC EXCELLENCE
Through Publications in International Scientific Journals

Total
900+
publications

Publication of JSI articles in top scientific journals (Elsevier CiteScore)

68 %
articles in **the top 25%** of scientific journals.

40 %
articles in **the top 10%** of scientific journals.

20 %
articles in **the top 5%** of scientific journals.

3 %
articles in **the top 1%** of scientific journals.

**Data are for 2023, data acquisition 18.01.2024, source: SciVal

Publication of JSI articles in top scientific journals (Web of Science)

42,477
citations of all JSI articles

909
number of published JSI articles

** Data are for 2023

Researchers at the Jožef Stefan Institute continued to publish extensively in scientific journals in 2023. The most prominent publications are presented by individual areas according to the prestige of the journal. At the forefront is certainly the achievement of Prof. Dr Dragan Mihailović and Prof. Dr Peter Prelovšek, who published in one of the most prestigious scientific journals, Nature. Together with Petra Šutar, who synthesized the material, and researchers from Italy and Germany, they revealed an unusual quantum effect in which the properties of a quantum material change dramatically when inserted into a cavity with cooled mirrors. The authors expect a lot of interest from the scientific community, as the observed effect opens the way for research into this surprising new quantum phenomena, which is unusual enough to trigger a series of different explanations.

Also special in 2023 is the sheer weight of publications by the research group of Prof. Dr Dragan Mihailović; this year alone, they managed to publish their achievements in five scientific journals in just the last three months of the year. Various aspects of this research have been reported in the journals Nature, Science Advances, Nature Communications twice and again Nature Photonics. The group's work is the result of a discovery reported a few years ago in the journal Science. This publication spurred a lot of new research around the world, as well as

the development of useful devices, such as memory elements, which were reported in several publications in 2022. The findings also resulted in a so-called scientific spin off, which led to wider interest in the field of quantum technologies. The results of the work of researchers at the Jožef Stefan Institute found their place in the most prestigious scientific journals in 2023.

In 2023, the researchers at the Institute also had two publications in the journal Advanced Materials. Dr Vesna Ribič, Dr Vanja Jordan and Prof. Aleksander Rečnik from the Department of Nanostructural Materials, Dr Sandra Drev from the Centre for Electron Microscopy, Dr Janez Kovač from the Department of Surface Technology and Optoelectronics and Prof. Goran Dražić from the National Institute of Chemistry, when studying the growth of rutile fibres, the so-called dissociative interaction between mineral surfaces and water was observed, which opens up a new direction of research in catalytic water fission. The study was published in an article titled Mnemonic Rutile-Rutile Interfaces Triggering Spontaneous Dissociation of Water. Dr Luka Pirker and Prof. Dr Maja Remškar from the Department of Solid State Physics, together with colleagues from the University of Regensburg, Germany, published an article entitled Non-Destructive Low-Temperature Contacts to MoS_2 Nanoribbon and Nanotube Quantum Dots in the journal Advanced Materials.

Several publications, which were further enhanced by the prestige of the journal, were contributed by the research group of Prof. Dr Boris Rogelj. He, together with assist. Dr Helena Motaln, young researcher Urša Čerček and colleagues from Germany, Switzerland and the Netherlands discovered a change in the protein FUS, which is involved in the early development of frontotemporal dementia disease (FTD). The achievement was published in the journal Brain. Prof. Dr Boris Rogelj and his colleagues Urša Čerček and Dr Mirjana Malnar Černigoj, as well as researchers from Germany, Great Britain and Canada, also discovered a new mechanism related to the C9orf72 gene mutation, which will now bring them even closer to discovering the causes of the formation of FTD and ALS. The results of the study were published in Nature Communications.

Researchers from the Independent Laboratory for Open Systems and Networks published a detailed analysis of the use of artificial intelligence (AI) methods for cybersecurity in the scientific journal Information Fusion with an impact factor of 18.6. In this article, they systematically presented examples of the use of AI methods for the identification, protection, detection, response and recovery, and analysed which methods are best suited for which security purposes. Researchers in the field of electronics and information technologies also proved themselves with publications in various scientific journals in 2023, and since this field, compared to physics or chemistry, gets its scientific recognition differently, we are publishing the widest possible range in our annual review. In 2023, the electronics researchers also proved themselves by organising a number of interesting and important events, among which the European School of Artificial Intelligence should be highlighted. »Artificial intelligence touches more and more areas of our lives and our future,« said Sašo Džeroski, co-organizer of the conference and head of the Knowledge Technologies Department. 2023 also represented the first year of ChatGPT. As Džeroski described, »it is a model for processing natural language that has the ability to generate humanlike text based on entered text. It is important to emphasize that ChatGPT is merely a software solution and does not have its own consciousness or awareness. It works on the patterns it perceived during training and doesn't understand the content in the same way as a human.« The emergence of ChatGPT and generative artificial intelligence was also explored by some members of the Institute and in their reflections in the media, round tables and various lectures they highlighted the fact that advances in science and technologies are very beneficial for the progress of mankind.

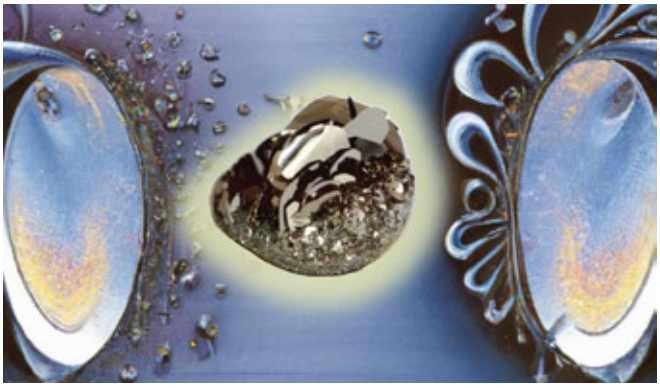
Mihailović and Prelovšek Reveal an Unusual Quantum Effect

Journal: **Nature**

Authors: Giacomo Jarc, Shahla Yasmin Mathengattil, Angela Montanaro, Francesca Giusti, Enrico Maria Rigoni, Rudi Sergo, Francesca Fassioli, Stephan Winnerl, Simone Dal Zilio, **Dragan Mihailović**, **Peter Prelovšek**, Martin Eckstein, Daniele Fausti

The head of the Department of Complex Matter at the Jožef Stefan Institute, Prof. Dr Dragan Mihailović, and a colleague from the Theoretical Physics Department, Prof. Dr Peter Prelovšek, in cooperation with researchers from Italy and Germany, revealed an unusual quantum effect, in which the properties of a quantum material change greatly when inserted into a cavity with cooled mirrors. The findings were published in Nature, the most prestigious scientific journal, in the article Cavity-mediated Thermal Control of Metal-to-Insulator transition in 1T-TaS_2.

Quantum materials have the property to derive macroscopic properties from quantum microscopic phenomena and cannot be understood solely through classical physics and chemistry. Sometimes they behave completely contrary to intuition. The compound 1T-TaS_2, so-called 1T phase tantalum disulphide, has been the subject of research all over the world for the past 30 years, and its unusual properties, such as the transition from metal to insulator, have attracted even greater attention in the last 9 years thanks to research at the Jožef Stefan Institute. Thus, researchers prepared the design of the experiment years ago, when correspondingly large crystals were specially synthesized for its implementation. After preliminary experimental results, they were discussed for two years, and became more focused at an international workshop on nonequilibrium quantum phenomena in Slovenia last year.



After the first analysed results, the researchers at the Jožef Stefan Institute, Prof. Dr Dragan Mihailović and Prof. Dr Peter Prelovšek, became involved in a theoretical and experimental discussion on the experiment and devised possible explanations. In the paper, published in the journal Nature, together with authors from Italy and Germany, led by Dr Daniel Fausti of the Universities of Trieste and Erlangen, and with his student Giacomo Jarc, they revealed an unusual quantum effect in which the properties of quantum material change dramatically when inserted into a cavity with cooled mirrors. The experiment, seemingly simple, suggests an unusually large change in the transition temperature between the insulator and the metal in the 1T-TaS_2 crystal, which is a substance with very interesting properties closely related to quantum physics. The phenomenon is unusual because the material is not in contact with the environment during the experiment, and the influence of mirrors indicates a strong coupling between the electrons in matter and quantum fluctuations of the electromagnetic field, or light in vacuum-photons, which in turn alters the transition temperature.

The new, unusual effect is purely fundamental, but it also has potential uses, for example, in special sensors. Importantly, the experiment opens the way for research into new quantum effects and highlights 1T-TaS_2 as being at the forefront of interesting quantum materials.

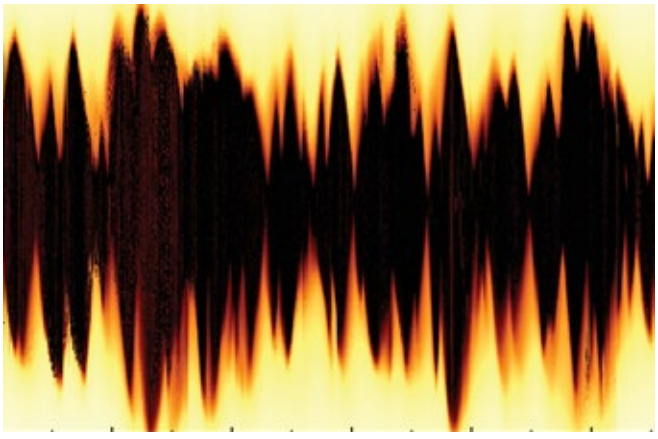
The material was synthesized by Petra Šutar from the Jožef Stefan Institute, while Prof. Dr Peter Prelovšek and Prof. Dr Dragan Mihailović participated in theoretical and experimental work, including calculations, and in writing the article. The authors expect a lot of interest from the scientific community, because the effect they discovered is surprising, but at the same time unknown enough to provoke a series of different explanations.

A New Way to Make Bismuth Electrical Contacts on MoS_2

Journal: **Advanced Materials**

Authors: Robin T. K. Schock, Jonathan Neuwald, Wolfgang Möckel, Matthias Kronseder, **Luka Pirker**, **Maja Remškar**, Andreas K. Hütte

Dr Luka Pirker and Prof. Dr Maja Remškar from the Department of Solid State Physics at the Jožef Stefan Institute, together with colleagues from the University of Regensburg, Germany, published the article Non-Destructive Low-Temperature Contacts to MoS_2 Nanoribbon and Nanotube Quantum Dots in the journal Advanced Materials. Molybdenum disulphide (MoS_2) has been fascinating researchers with its exceptional properties for more than a decade. Among other things, it is distinguished by its unique electrical properties, which makes it interesting for electronic applications, from transistors and sensors to quantum computers. In the published paper, the researchers presented a new way of making electrical contacts using bismuth on MoS_2 nanotubes and nanostrips that were synthesized at the JSI. Good electrical contacts are an important step towards quantum technologies, as most measurements take place at extremely low temperatures (T < 100 mK). This new finding will enable researchers to discover new laws in the quantum regime in MoS_2.

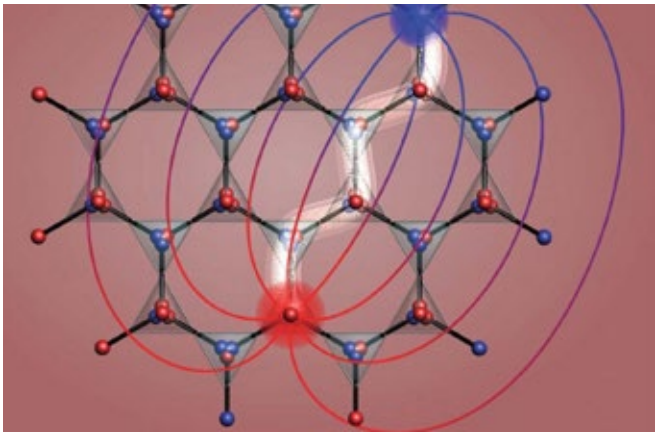


Overview of the Latest Developments in Quantum and Topological States of Materials

Journal: **Advanced Materials**

Authors: J. Khatua, B. Sana, **A. Zorko**, **M. Gomilšek**, K. Sethupathi, M. S. Ramachandra Rao, M. Baenitz, B. Schmidtf, P. Khuntia

Prof. Dr Andrej Zorko and Assist. Prof Dr Matjaž Gomilšek from the Department of Solid State Physics at the Jožef Stefan Institute and their co-authors from India and Germany published the article Experimental Signatures of Quantum and Topological States in Frustrated Magnetism in the journal Physics Reports. The article provides an overview of the latest advances in quantum and topological states of materials derived from magnetic frustration, such as spin ice (with excitations that behave like magnetic monopoles), quantum spin fluids (potential platforms for more robust quantum computers), and topological spin textures such as skyrmions (for spintronic circuits – magnetic analogues of electronic circuits). The characteristic experimental signs of these exotic, and often elusive, states are exposed, and the most appropriate experimental techniques for their characterization are presented. The article provides a comprehensive overview of possible guidelines for further development of this area and highlights the potential for practical applications and for solving important open issues in modern condensed-matter physics.

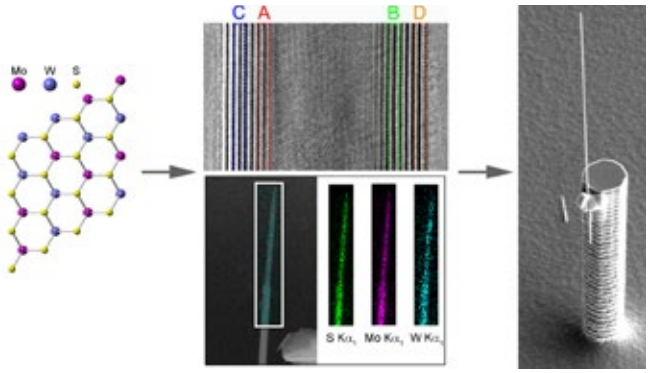


One of the First in the World to Synthesize and Characterize Mixed $MoWS_2$ Nanotubes

Journal: **Advanced Functional Materials**

Authors: **Luka Pirker**, Robert Ławrowski, Rupert Schreiner, **Maja Remškar**, **Bojana Višić**

Members of the Department of Solid State Physics at the Jožef Stefan Institute, Dr Luka Pirker, Prof. Dr Maja Remškar and Dr Bojana Višić, as well as Robert Ławrowski and Rupert Schreiner from OTH Regensburg in Germany, published an article entitled $Mo_xW_{x-1}S_2$ Nanotubes for Advanced Field Emission Application, where they were among the first in the world to synthesize and characterize mixed $MoWS_2$ nanotubes. In recent years, metal dichalcogenides (MoS_2, WS_2, etc.) have attracted a lot of interest due to their exceptional properties, as they show great potential in many areas, including devices for electron field emission. Due to their layered structure, such materials can significantly increase the local electric field, which plays an important role in the emission of electrons. In a published paper, the researchers synthesized nanotubes from two different metals, which could further improve the material properties to increase the efficiency of emission devices. Devices from individual nanotubes could pave the way for a new generation of devices for electron field emission in the future.

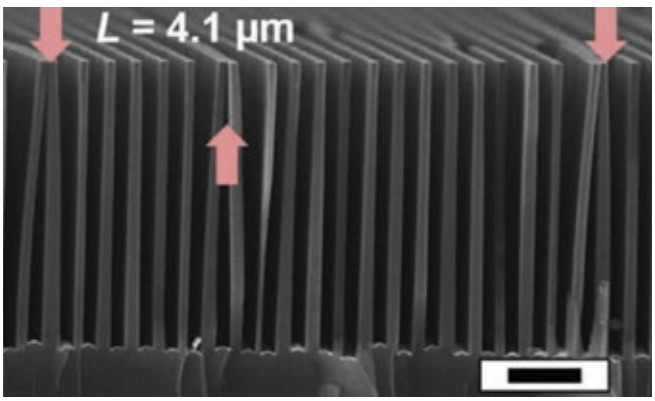


New Method for the Manufacture of Lamellar Structures

Journal: **Advanced Functional Materials**

Authors: Martyna Michalska, Alessandro Rossi, **Gašper Kokot**, Callum M. Macdonald, Silvia Cipiccia, Peter R. T. Munro, Alessandro Olivo, Ioannis Papakonstantinou

A team from University College London in the UK and Dr Gašper Kokot from the Department of Complex Matter at the Jožef Stefan Institute published an article entitled Fabrication of High-Aspect Ratio Nanogratings for Phase-Based X-Ray Imaging in the journal Advanced Functional Materials. Optical diffraction elements such as a periodic gratings are a basic element in X-ray imaging, which medical research, materials science and safety checks rely on. A new method was developed for the manufacture of lamellar structures with nano-scale spacings and height on a micron scale with a height-to-width ratio of over 40. Their excellent diffraction qualities were shown using a synchrotron. In addition to the successful application of these structures in the context of an X-ray diffraction grating, the physical limitations of the method and the stability of such structures in general were theoretically investigated. The production of such gratings is important for a range of applications, from sensors, batteries, solar cells, and superhydrophobic surfaces to mechanical-bactericidal materials.

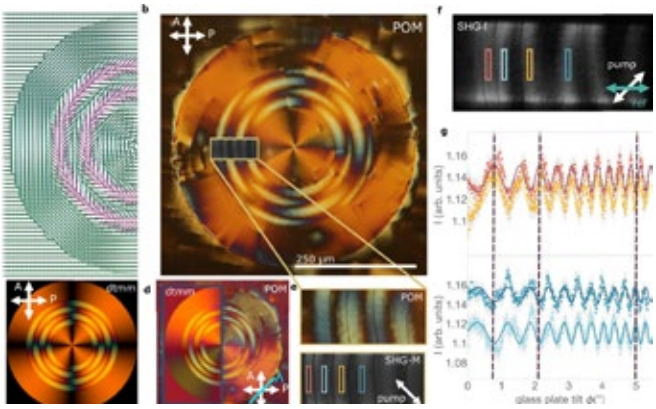


New Polarisation Sampling Options

Journal: **Nature Communications**

Authors: **Nerea Sebastián**, **Matija Lovšin**, Brecht Berteloot, **Natan Osterman**, Andrej Petelin, Richard J. Mandle, Satoshi Aya, Mingjun Huang, **Irena Drevenšek-Olenik**, Kristiaan Neyts, **Alenka Mertelj**

Researchers Nerea Sebastián, Matija Lovšin, Natan Osterman, Irena Drevenšek Olenik and Alenka Mertelj from the Department of Complex Matter at the Jožef Stefan Institute and the Faculty of Mathematics and Physics of the University of Ljubljana, in collaboration with researchers from the University of Ghent in Belgium, the University of Leeds in the UK and the South China University of Technology in China, reported in the journal Nature Communications the sampling of electrical polarization in ferroelectric nematic liquid crystals using a flexoelectric phenomenon. In addition to the functional combination of fluidity, processability and anisotropic optical properties inherent in all types of liquid crystals, recently discovered ferroelectric nematic fluids are distinguished by a striking range of additional physical properties derived from structural polarity and the associated spontaneous electrical polarization of the phase. These new polarization sampling options open a promising new path for designing photon structures based on ferroelectric nematics and consequently applying them to various technological fields.

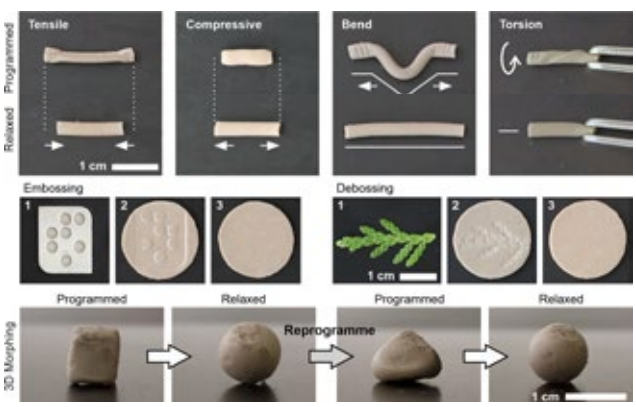


New Material with Design Memory

Journal: **Nature Communications**

Authors: **Matej Bobnar**, **Nikita Derets**, **Saide Umerova**, Valentina Domenici, **Nikola Novak**, **Marta Lavrič**, **George Cordoyiannis**, **Boštjan Zalar**, **Andraž Rešetič**

The current development of soft materials with shape memory is mostly limited to the synthesis of thin samples or depends on complex and slow methods for producing larger three-dimensional specimens. This greatly limits their practical application. Members of the Department of Solid State Physics at the Jožef Stefan Institute, M. Bobnar, N. Derets, S. Umerova, N. Novak, M. Lavrič, G. Cordoyiannis, B. Zalar and A. Rešetič, and V. Domenici from Italy published an article in the journal Nature Communications, presenting a new material with a design memory, made from a dispersion of the main-chain liquid-crystal elastomer microparticles in a silicone matrix. The composite material can be poured into any shapes and sizes, especially into larger full-volume patterns. With thermal cycling, samples can be mechanically programmed into new, stable shapes, which are reset to the original shape by repeated heating. Due to its practical production and unique design responses, the material is particularly suitable for implementation in advanced applications, such as active elements in soft robotics.



Researchers Visualize the Microscopic Dynamics of Electrons in a Metastable State of 1T-TaS_2

Journal: **Nature Communications**

Authors: **Anže Mraz**, **Michele Diego**, **Andrej Kranjec**, **Jaka Vodeb**, Peter Karpov, **Yaroslav Gerasimenko**, **Jan Ravnik**, **Yevhenii Vaskivskyi**, **Rok Venturini**, **Viktor Kabanov**, Benjamin Lipovšek, Marko Topič, **Igor Vaskivskyi**, **Dragan Mihailović**

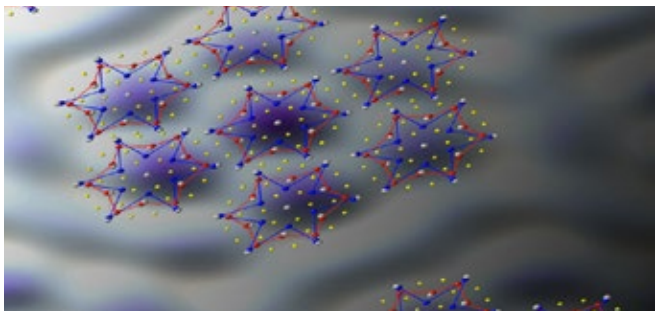
The metastability of quantum systems is rare and still poorly understood. In an article recently published in Nature Communications, Anže Frost and his colleagues in the group of Prof. Dr Dragan Mihailović, in cooperation with the Faculty of Electrical Engineering of the University of Ljubljana, managed to visualize the very unusual microscopic dynamics of electrons in the metastable state of 1T-TaS_2. Using a multipeak, low-temperature tunnel microscope, they showed that the injected electrons form topologically complex networks that cannot easily return to the basic ordered state on the crystal lattice. It is especially surprising that in these networks the charge on the electrons is no longer integer, but assumes fractional values such as 13/10, 23/40 and 3611/5000. The number of different fractions turns out to be very large, but finite. The possibility of manipulating the topological interlacing of such networks with an electric current via an external circuit points the way to finding metastable states in multiparticle quantum systems, as well as in making new quantum devices for use in quantum computers.

First Observation of Polarons at high Temperatures in a TaS_2 Crystal

Journal: **Nature Communications**

Authors: E. S. Bozin, M. Abeykoon, S. Conradson, G. Baldinozzi, **P. Šutar**, **D. Mihailović**

A team of physicists at the Jožef Stefan Institute led by Prof. Dr Dragan Mihailović conducted an experiment with colleagues from France and the USA, which for the first time reported on the existence of individual polarons at very high temperatures in a TaS_2 crystal. They are able to detect the movements of ions surrounding individual electrons as they move across a crystal at very high temperatures on an ultrashort time scale of 10^{-12} of a second. When the temperature drops, they can track the formation of a polaron crystal, which retains the characteristic deviations of the ions seen in individual polarons. The resulting state is superconducting at low temperatures, but forms a quantum spin fluid at intermediate temperatures, the signature of which is the symmetry of the movements of the polar network. The work has impact in many areas of physics, and the pioneering method opens the way to finding polarons in other important materials. TaS_2 is a material with interesting properties, especially metastable states for use in computer memories, reported in many recent articles in Science and Nature. The work was published in Nature Communications.

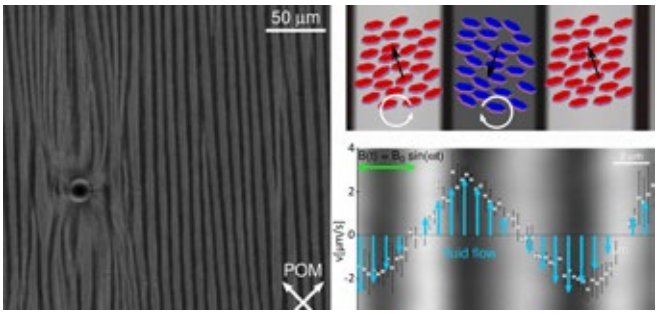


Spontaneous Chiral Symmetry Breaking and Lane Formation in Ferromagnetic Ferrofluids

Journal: **Small**

Authors: **Mojca Vilfan**, **Borut Lampret**, **Žiga Gregorin**, **Luka Cmok**, **Andrej Vilfan**, Jürgen Klepp, Joachim Kohlbrecher, **Patricija Hribar Boštjančič**, **Darja Lisjak**, **Alenka Mertelj**

Researchers from the Department of Complex Matter, Assist. Prof Dr Mojca Vilfan, Borut Lampret, Žiga Gregorin, Dr Luka Cmok, Dr Patricija Hribar Boštjančič, and Assist. Prof Dr Alenka Mertelj and Prof. Dr Darja Lisjak from the Department of Materials Synthesis and Dr Andrej Vilfan from the Department of Solid State Physics at the Jožef Stefan Institute and colleagues from abroad published an article entitled Spontaneous Chiral Symmetry Breaking and Lane Formation in Ferromagnetic Ferrofluids in the journal Small. In it, the authors describe a spontaneous fracture of chiral symmetry in ferromagnetic ferrofluids. These are suspensions of magnetic nanoplates in a liquid, which at sufficiently high concentrations settle and the suspension becomes ferromagnetic. In an alternating magnetic field, a striped structure is visible under a polarization microscope for certain fluid conditions, which the authors explain by the formation of magnetic domains. Spontaneous symmetry fracture leads to the rotation of particles and, as a result, to the formation of liquid flows, which, despite the homogeneous field in adjacent lines, proceeds alternately in opposite directions.

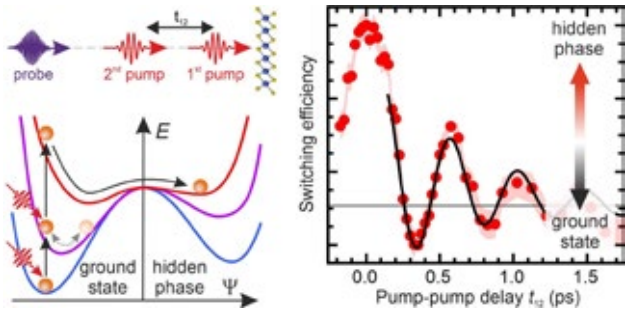


The Importance of Collective Excitement

Journal: **Science Advances**

Authors: Julian Maklar, Jit Sarkar, Shuo Dong, **Yaroslav A. Gerasimenko**, Tommaso Pincelli, Samuel Beaulieu, Patrick S. Kirchmann, Jonathan A. Sobota, Shuolong Yang, Dominik Leuenberger, Robert G. Moore, Zhi-XunShen, Martin Wolf, **Dragan Mihailović**, Ralph Ernstorfer, Laurenz Rettig

Active control of quantum materials is highly desirable for a wide range of applications. Metastable hidden states such as the one discovered years ago by researchers from the Department of Complex Matter at the Jožef Stefan Institute offer completely new functionalities. However, the fundamental mechanisms leading to hidden states remain largely an open scientific topic. In a new study published in November 2023 in Science Advances, Prof. Dr Dragan Mihailović, together with a team of researchers from Germany and the United States, investigated the coherent control of the transition to a metastable hidden quantum state in the quantum material 1T-TaS_2. Temporally and angularly detachable photoemission spectroscopy (trARPES) was used to investigate the electronic and collective excitations during the transition to a hidden state in real time. With the optical excitation laser method and a time-controlled sequence of shocks, they managed to coherently control the transition to the hidden phase, thus revealing the importance of collective excitation and thus helping to clarify the mechanism for this interesting phenomenon.

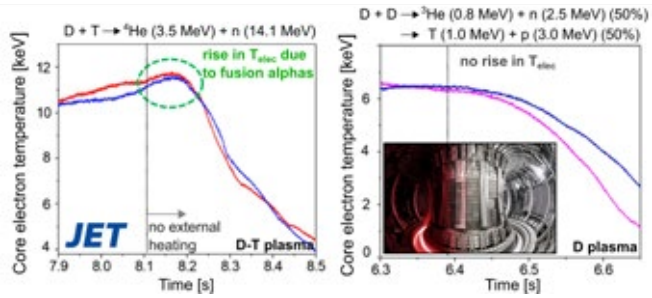


Štancar in Experiment on the Tokamak JET

Journal: **Physical Review Letters**

Authors: V. G. Kiptily, R. Dumont, M. Fitzgerald, D. Keeling, S. E. Sharapov, M. Poradzinski, **Ž. Štancar**, P. J. Bonofiglo, E. Delabie, Z. Ghani, V. Goloborodko, S. Menmuir, E. Kowalska-Strzeciwilk, M. Podestà, H. Sun, D. M. Taylor, J. Bernardo, I. S. Carvalho, D. Douai, J. Garcia, M. Lennholm, C. F. Maggi, J. Mailloux, F. Rimini, P. Siren

Dr Žiga Štancar, a former associate of the Reactor Physics Department at the Jožef Stefan Institute, participated in the implementation of the first direct experimental observation of the self-heating of thermonuclear fusion plasma with alpha ions in deuterium-tritium (DT) plasma, which is an important step on the road to demonstration fusion reactors. Under the direction of Dr Vasily Kiptily of UKAEA, the researchers conducted an experiment with DT and comparably pure deuterium (D) plasma and heated it by the external injection of neutral particles, achieving a high plasma temperature and fusion speed. A comparison of the properties of two plasmas immediately after the external heating was turned off showed that the temperature of the plasma electrons in D plasma decreased, while in DT plasma this increased by an additional 100 milliseconds. The increase in electron temperature without external plasma heating was attributed to the energy transfer of the fast alpha particles formed by DT fusion, which was confirmed by plasma simulations. The results of the experiment on the Joint European Torus (JET) tokamak were published in the journal Physical Review Letters.

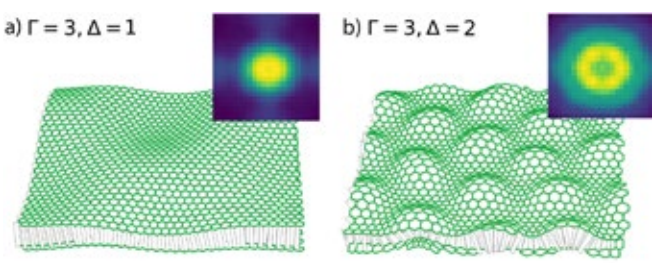


Researchers Investigate Theoretical Model of Unsupported Epithelial Tissues

Journal: **Physical Review Letters**

Authors: **Urška Andrenšek**, **Primož Ziherl** in **Matej Krajnc**

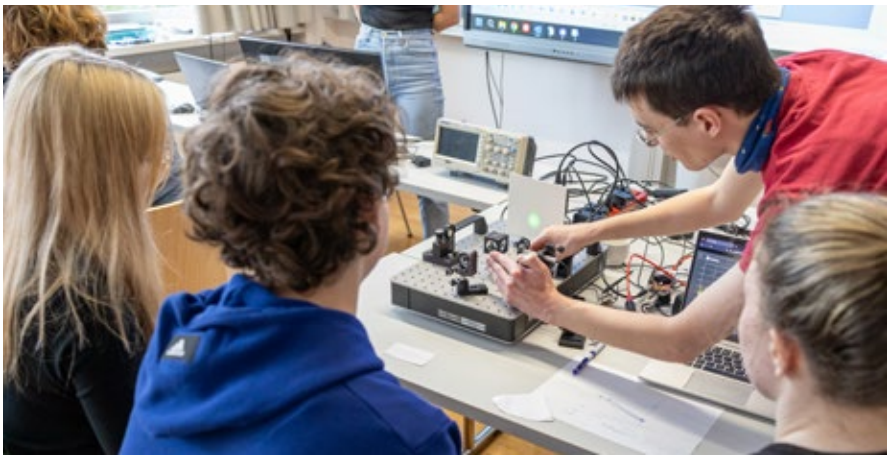
Urška Andrenšek, Primož Ziherl and Matej Krajnc from the Theoretical Physics Department of the Jožef Stefan Institute published an article entitled Wrinkling Instability in Unsupported Epithelial Sheets in the journal Physical Review Letters. In their work, the authors explored a theoretical model of unsupported epithelial tissues with apico-basal differential surface tension and supported analytical derivations with numerical tissue simulations. They showed that, unlike non-biological thin layers, epithelial tissues can autonomously wrinkle and determined the size of their surface deformities. Wrinkling in supported non-biological thin layers subjected to uniaxial contact is due to the balance of contributions of the bending energy of the layer and the elastic energy of the substrate. In their work, the authors presented the hitherto unexplored folding mechanism, which is based on the balance between the contributions of the surface energies of the apical and basal sides of the epithelial tissue. The proposed model thus explains the mechanism that allows epithelial tissues to autonomously control the size order of their surface deformations without the need to interact with supporting structures.



World Quantum Day

Ljubljana, April 2023

April 14 is World Quantum Day, which aims to promote the understanding of quantum science among the public. To this end, the Slovenian Community for Quantum Technologies and the Jožef Stefan Institute prepared a series of events.



First, at a workshop, students learned about the basics of quantum physics. Participants were also able to visit laboratories to investigate quantum phenomena and assemble quantum devices. They were also able to test the acquired basics and assemble optical devices themselves.

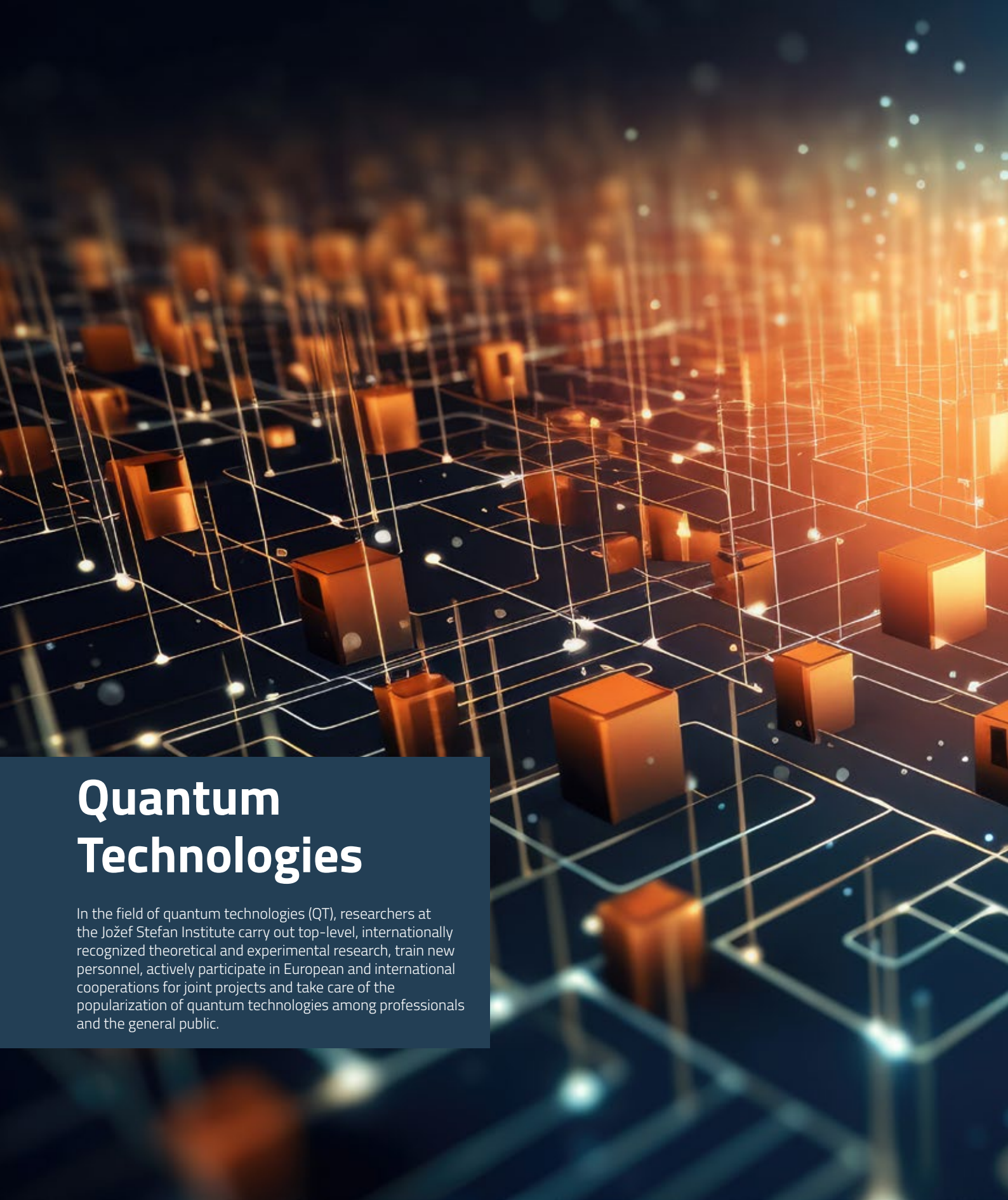
On 18 April, several lectures were held at the JSI, at which experts presented various research activities in the field of quantum science. As part of a guest lecture, quantum physicist and professor Tommaso Calarco from the Forschungszentrum Research Institute in Jülich, Germany, presented opportunities in the field of quantum technologies and possibilities for cooperation between Slovenia and other countries.

Calarco was the main initiator of the European Quantum Manifesto, which led to the creation of the EU's Quantum Flagship programme. Within the latter, he runs the Quantum Community Network, which is one of the management and coordinating bodies of the project.

The guest lecture was followed by lectures from Slovenian researchers, who presented, among other things, quantum research at the JSI and QuantERA projects, and touched on the topic of quantum computers and work in the laboratory for quantum optics at the Faculty of Mathematics and Physics of the University of Ljubljana.

On April 19, 2023, a lecture by Philippe Bouyer, professor and coordinator of the Third Catalyst (CAT 3) programme, took place. He introduced the use of quantum sensing at Quantum Delta NL, a foundation connecting knowledge institutions in the field of quantum technology in the Netherlands.

World Quantum Day is celebrated on April 14, a reference to the rounded first digits of the Planck constant 4.14. It is named after the German physicist Max Planck and represents the basic physical constant that occurs in the equations of quantum mechanics to describe the size of quanta. As stated on the World Quantum Day website, the purpose of World Quantum Day is to engage the public in understanding and discussing quantum science and technology, and above all to find answers to questions about how physicists and others in quantum science help to understand nature at its most fundamental level, how it has helped develop technologies that are crucial to our lives today, and how it can lead to future scientific and technological revolutions and how they can affect our society.



Quantum Technologies

In the field of quantum technologies (QT), researchers at the Jožef Stefan Institute carry out top-level, internationally recognized theoretical and experimental research, train new personnel, actively participate in European and international cooperations for joint projects and take care of the popularization of quantum technologies among professionals and the general public.

The field of QTs is evolving incredibly fast; it can be compared to the early years of the Internet.
QTs combine research disciplines (physics, optics, electrical engineering, computer science, applied mathematics, cryptography) and industrial activities (measurement and testing, control systems, laser technology, communications, computer science hardware and software). The social and economic impacts of QTs are numerous, they include the development of miniaturized smart devices for the consumer, humanoid robotics, safer telecommunications and more efficient logistics to improve cyber and financial security, the development of sustainable farming and the optimised exploitation of natural resources.
QTs create economic, strategic, scientific, technological and social benefits. It is clearly an area that is treated in different national and international institutions and at different levels.

Researchers in QTs at the Jožef Stefan Institute:

- perform leading theoretical and experimental research thanks to a long tradition in quantum physics, from superconducting technologies and quantum devices to cold atoms, quantum optics, the theory of quantum information, multi-particle quantum physics and quantum materials,
- train new personnel,
- actively participate in European and other projects,
- popularise QTs for the professional and general public.

JSI's Employees Contribute to Greater Security of the Slovenian Transmission Network

Ljubljana, July 2023

In 2023, members of the Department of Communication Systems, successfully completed the TRAFOFLEX project, in which they developed, implemented and validated a model for describing the thermal state of energy transformers, which has been in operational use since the completion of the project, in cooperation with the Milan Vidmar Electric Power Research Institute, the Elektro Gorenjska company and the subsidiary of the Slovenian transmission operator Operato.

The TRAFOFLEX project represents a new piece in the mosaic of the Department of Communication Systems' contributions to the development of smart grids, with an emphasis on decision support systems at critical moments that increase the level of operating safety and the capacity of strategic infrastructure. The beginnings of the activities of the department in this area date back to 2014, when Slovenia was hit by a violent ice storm, which caused damage to the order of €9 million to the transmission network alone. In the following year, the employees of the E6 department teamed up with the Milan Vidmar Electric Power Research Institute and the Environmental Agency of the Republic of Slovenia, and developed a system for warning of the possibility of ice formation on transmission lines for the Slovenian transmission operator ELES and proposed potential operational countermeasures. The prototype system was well received and elevated to TRL 8 with the help of FP7 financing Technology transfer in computing systems and thus introduced into operational operation in 2016. During the transfer of technology, an initiative came from the client for an additional study, where we were interested in another extreme, namely cable overheating. Based on experimental and numerical studies, we upgraded the existing operating recommendations and developed software that allows predictions of the thermal state of the transmission line cable according to the operating and weather conditions. The implemented software package enables monitoring of the entire transmission network in real time, achieves high reliability and industrial level of use (TRL 9). In 2018, the software was integrated into the DiTeR package, which won the tender of ELES for an operational dynamic assessment of the Slovenian transmission network. In 2019, the system was upgraded to take into account the uncertainty of weather and operating parameters, which further increased the confidence in forecasts. DiTeR has been marketed worldwide by Operato since 2020 and has so far been tested on pilot projects on the Croatian and Lithuanian transmission networks. Negotiations are currently underway to pilot the implementation of the system on Canadian, Israeli and Uruguayan networks. Starting in 2023, the E6 department is also helping the Bavarian operator TransnetBW to switch from static to dynamic operation, and the H2020 project Holistic Approach towards Empowerment of the DiGitalization of the Energy Ecosystem through adoption of IoT solutions, where the E6 department will develop modules for local thermal assessment of electric power elements. The budget of the described studies and technology transfers into practice has so far been slightly less than €1 million.

Analysis of the Use of Artificial Intelligence Methods for Cybersecurity

Journal: **Information Fusion**

Authors: **Ramanpreet Kaur**, **Dušan Gabrijelčič**, **Tomaž Klobučar**

Researchers from the Independent Laboratory for Open Systems and Networks, Dr Ramanpreet Kaur, Dr Dušan Gabrijelčič and Assist. Prof Dr Tomaž Klobučar, published a detailed analysis of the use of artificial intelligence (AI) methods for cybersecurity in the September issue of the scientific journal Information Fusion with an impact factor of 18.6. In this article, the authors systematically present examples of the use of AI methods for identification, protection, detection, response and recovery, and analyze which methods are best suited to specific security purposes. The results provide a comprehensive insight into AI's potential to improve cybersecurity in a variety of contexts, such as handling a large number of security-relevant events and detecting malicious code, malicious users and security anomalies faster and more effectively. It also identifies research gaps and opportunities in several areas of research and development, i.e., in emerging cybersecurity areas and in new AI methods, data demonstration and infrastructure development for the successful deployment of AI-based cybersecurity.

Improve Quantum Glow Performance Using Machine Learning Methods

Journal: **Quantum Machine Intelligence**

Authors: **Jure Brence**, **Dragan Mihailović**, **Viktor Kabanov**, **Ljupčo Todorovski**, **Sašo Džeroski**, **Jaka Vodeb**

An article entitled Boosting the Performance of Quantum Annealers Using Machine Learning – Improving the Performance of Quantum Glows Using Machine Learning was published in the journal Quantum Machine Intelligence, the authors of which come from the Department of Knowledge Technologies and the Department of Complex Matter at the Jožef Stefan Institute, the Jožef Stefan International Postgraduate School, the Nanocentre and the Faculty of Mathematics and Physics, University of Ljubljana. In the article, the researchers Jure Brence, Prof. Dr Dragan Mihailović, Prof. Dr Viktor V. Kabanov, Prof. Dr Ljupčo Todorovski and Prof. Dr Sašo Džeroski, led by Dr Jaka Vodeb, managed to minimize the noise in quantum annealers using machine-learning methods, thereby improving their performance. Quantum annealers are an entirely new type of computers that leverage the quantum dynamics of microscopic quantum bits to effectively solve optimization problems. They managed to remove the impact of noise to such an extent that they improved the ability of quantum beams to operate by three orders of magnitude, thereby opening the way to solving more complex problems.

Information Society Multiconference 2023

From 9 to 13 October 2023, the 26th Information Society multiconference took place at the Jožef Stefan Institute. Each year, the International Multiconference allows researchers to present their latest research and discoveries from various areas of the information society. This time it consisted of 10 conferences covering a wide range of research fields: Discovering knowledge and data warehouses, Demographic and family analysis, Legends of Computer and Information Science, Conference on Healthy Longevity, Myths and Truths on Environmental Protection, Digital Inclusion in the Information Society, International Technology Transfer Conference, Slovenian Conference on Artificial Intelligence, Cognitive Science, Education in the Information Society. At the closing event with the guest of honour, Nataša Pirc Musar, President of the Republic of Slovenia, awards were also presented to Andrej Brodnik for his lifetime achievement, the award for best achievement in the field of information society, RTV's portal Dostopno, and the award for achievement in 2022 in the field of the information society in the past year was received by Benjamin Bajd, winner of a gold medal in programming at the 34th Computer Olympics.

A Study by the Department of Computer Systems on Possibilities for Improving Traffic-Flow Forecasting

Journal: **European Transport Research Review**

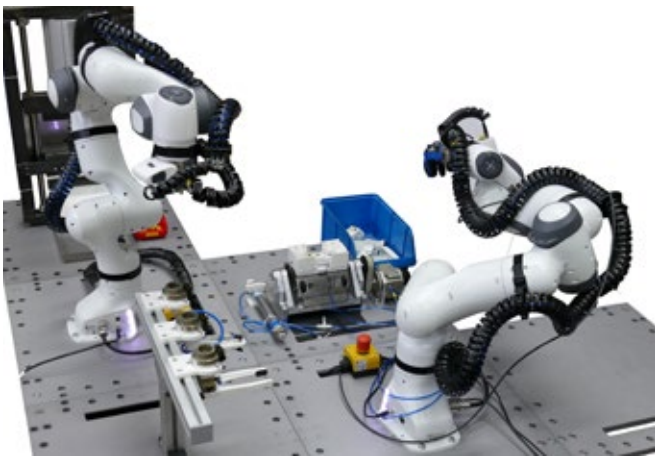
Authors: **Gašper Peterlin**, **Rok Hribar**, **Gregor Papa**

Effective traffic management is essential for ease of movement in a city. A recent study by the Department of Computer Systems E7, published in the journal European Transport Research Review, presents options for improving traffic-flow forecasting, even without real-time data, thus improving existing traffic-management strategies. By integrating historical traffic patterns with weather conditions and public holidays, the new approach enables accurate modelling of traffic dynamics. The evaluation with real traffic data from Ljubljana shows a promising insight into traffic behaviour. The approach offers practical solutions to realistic scenarios and is an important step towards more efficient transport systems.

A New Method for Autonomous Learning to Disassemble Objects with Robots

Journal: **Robotics and Computer-Integrated Manufacturing**
Authors: **Mihael Simonič**, **Aleš Ude**, **Bojan Nemec**

Researchers from the Department of Automation, Biocybernetics and Robotics at the Jožef Stefan Institute have developed a new method for autonomous learning of decomposing objects with robots. While autonomous robotic learning is often very time consuming, a robot can quickly find the optimal solution with the proposed approach. The basis for a quick search is to take into account the physical limitations that arise during the dismantling of objects, which can significantly reduce the search space. The proposed method was published by the authors Dr Mihael Simonič, Prof. Dr Aleš Ude and Prof. Dr Bojan Nemec in an article Hierarchical Learning of Robotic Contact Policies, which was published in the prestigious journal Robotics and Computer-Integrated Manufacturing. The research was created within the framework of the project Automatic reconfiguration of a robotic cell for the recycling of electronic devices (ReconCycle) from Horizon 2020, coordinated by Prof. Ude. The method will contribute to the faster development of applications for the robotic recycling of electronic products, which is only possible with robots with a high degree of adaptivity. This is indispensable due to the great variability of electronic devices.



JSI Participated in the Preparation of the Transnational Ageing Strategy

The Centre for Smart Cities and Communities and the Departments of Computer (E7) and Intelligent Systems (E9) of the Jožef Stefan Institute are completing their work on the SI4CARE project in May, after almost three years. The work included the successful testing of thirteen pilot projects and the preparation of a transnational ageing strategy and eight action plans. Slovenia carried out four of these pilot projects, which included the opening of a unit for people with dementia to promote activities, improving access to comprehensive long-term care, developing a mobile application for heart-failure management (E9) and creating a system for personalized exercise based on biomechanical measurements (E7). With the support of the project partners, the University of Ljubljana established a multidisciplinary R&D centre for the social innovation of active and healthy ageing. The aim is to become the European centre for active and healthy ageing. The project received international recognition and support from the European Commission, which sees it as a good example of an effective and functioning ecosystem for social innovation.

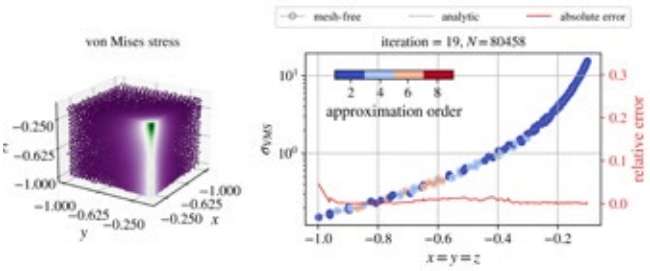
Progress in Traffic Management and Modelling

The Department of Computer Systems of the Jožef Stefan Institute, in cooperation with its research colleagues from Deusto University and the National Technical University of Athens, organized a special session on advanced traffic and fleet management on 25 September 2023 during the 26th IEEE International Conference on Intelligent Transport Systems (ITSC 2023) in Bilbao, Spain. From the point of view of traffic and vehicle management, we focus on operational concepts for the development of efficient, flexible and adaptable multimodal networks and traffic-management systems. These systems use innovative techniques to collect and aggregate data and make use of state-of-the-art technologies, including artificial intelligence and high-performance computing. This focus was reinforced in a special session, where experts presented advances in traffic management and modelling, behavioural analytics, travel modeling and efficient connected mobility. The session was well received and attracted many participants, who actively participated in the technical discussions.

Researchers Develop a Wireless Hp-Adaptive Method

Journal: **Engineering With Computers**
Authors: **Mitja Jančič**, **Gregor Kosec**

Researchers Mitja Jančič and Dr Gregor Kosec from the Department of Communication Systems at the JSI published an article entitled Strong Form Mesh-Free Hp-Adaptive Solution of Linear Elasticity Problem in the prestigious journal Engineering with Computers. Based on the original error indicator, the proposed method automatically detects areas in the computational domain where greater accuracy of the numerical solution is needed, where it simultaneously adjusts the accuracy of spatial discretization and the approximation order. The presented hp-flexible solution process is verified on two- and three-dimensional problems in the field of linear elastomechanics.



New Method for Predicting the Final Height of Children and Adolescents

Ljubljana, June 2023, source: STA

Researchers from the Jožef Stefan Institute and the Faculty of Sport of the University of Ljubljana have developed a new method for predicting the final height of children and adolescents. The method uses extensive population data collected over decades as part of the SLOfit program for schoolchildren (better known as measurements for the Sports Educational Chart). It compares the growth curve of a child, with the help of artificial intelligence, with peers who are most similar to him or her. The forecasts are therefore more accurate than those given by existing methods of predicting height.

»How tall will my child be when he or she grows up?« is a question that many parents ask. The answer is not simple, since it depends on many factors. But it is important to ask the question for several reasons. The first is medical. If the child does not grow as fast as he or she should, according to the percentile tables used by paediatricians, hormone therapy may be necessary. On the other hand, height plays an important role in discovering sports talent. A child who is gifted for basketball has almost zero chances of becoming the next Luka Dončić at the final height of 170 cm. But he can become a new Primož Roglič or Timi Zajc.

While a child's growth pattern can often be inferred from the growth curves of both parents, these are usually not easily accessible. Therefore, the most common approach used by paediatricians are, the already-mentioned percentile tables, where the doctor checks whether the child remains in the same percentile class for every year. However, they do not take into account the fact that the puberty growth spurt does not occur at the same time in everyone. Methods that take into account different groups of data to estimate final height in adulthood include additional measurements of body height, including invasive radiological examinations, or have only been designed by researchers on the basis of several hundred individuals.

In contrast, the Slovenian researchers developed a new algorithm for predicting height in adulthood based on a huge set of data collected within the framework of measurements for the Sports Educational Chart. Every year, the latter also contain measurements of height, weight and several parameters of physical performance from the child's entry into primary school, at the age of 6 or 7, to the end of secondary school, at the age of 18 or 19. At the same time, they cover the entire generation of Slovenian children from the 1980s onwards.

The new algorithm compares a child's growth curve using artificial intelligence with the height of the most similar people in the dataset, and uses this information to predict the future growth curve and adult height. It therefore goes significantly beyond existing models in terms of precision, partly due to the fact that more than 16,000 schoolchildren are included in the data. It is successfully integrated into the SLOfit website, where it is publicly available, and the study was published in the scientific journal PLOS One. The research was carried out as part of the European project Horizon 2020 CrowdHEALTH.

As part of the European project SmartCHANGE, we are just starting to continue with it. The project AI-Based Long-Term Health-Risk Evaluation for Driving Behaviour-Change Strategies in Children and Youth (SmartCHANGE) will focus on the development of a more effective prediction of chronic, non-communicable diseases (e.g., cardiovascular and metabolic diseases and various forms of cancer) in children and adolescents in their adulthood. The triggers of the latter are present at a young age, but with current methods of diagnosis they are not necessarily detected in time.

JSI Develops an Indoor Localization System

As part of the ECSEL JU InSecTT project, researchers from the Department of Computer Systems developed an innovative and cost-effective system for indoor localization and navigation. The system does not rely on positioning by satellites or data-communication networks, which makes it very suitable for the interiors of buildings where these signals are not available or are very weak. Our solution is a smartphone app that uses pre-generated QR codes attached to walls inside the building. These codes, combined with sensors of the smartphone's inertial measuring unit (IMU) processed by the PDR (pedestrian dead reckoning) algorithm, allow you to accurately determine the current position of the user. When the user's position is determined, we use the Dijkstra navigation algorithm, which guides the person to the desired destination. In addition, the smartphone app can act as a logistics service in the case of disasters. It enables the collection and sending of geo-referenced triage decisions to the cloud, which provides valuable support in emergency situations.

100th Anniversary of the Birth of the Electronics Pioneer France Bremšak

In 2023, 100 years have passed since the birth of Prof. Dr France Bremšak. Professor Bremšak laid the foundations for electronics development at the Jožef Stefan Institute. In 1952, when he was employed at the Institute, he founded the Laboratory of Electronics, which under his leadership developed into the Department of Electronics. In 1963, the department already comprised four labs, whose activity covered various fields, such as research on servo-mechanics, research in digital engineering and automata, the use of radioactive isotopes, the production of various instruments for nuclear physics, etc. Together with his colleagues, he laid the foundations from which all today's departments in the field of electronics and information technologies at the institute later developed. The most important achievement of Prof. Bremšak is the analogue computer, which he and his colleagues developed between 1957 and 1959. The analogue computer represented a top achievement in Europe and around the world and was initially intended primarily for process simulations in nuclear engineering, but later it was also used in other fields, and as such represented the basis for the development of mathematical modelling and simulation in Slovenia. On the occasion of the 100th anniversary of the birth of Prof. Bremšak, a memorial meeting was organised together with the Jožef Stefan Institute at the Faculty of Electrical Engineering of the University of Ljubljana, where the professor later continued his career.

New Book of the Communication Systems Department

Springer has published a book by colleagues from the Department of Communication Systems, Arsim Kelmendi, Aleš Švigelj, Tomaž Javornik and Andrej Hrovat, entitled Site Diversity in Satellite Communications: Modelling Using Copula Functions. The book is part of the Springer Briefs series. The book presents new models for predicting statistics on signal attenuation due to rain in terrestrial-satellite spatially diverse communication systems. All the important findings are collected, missing parts are listed and rounded to give the reader a complete picture of important modelling factors and how they are treated. The methodology for data processing for the statistical analysis is described, based on its own measurements of signal attenuation between the satellite and Earth. Four new models based on the functions of the copula are presented. The evaluation of the prediction error of the proposed models was evaluated by comparing them with measured data from other experiments with spatially diverse systems. The results presented in this book will help improve system design and further research in the field of modelling the next generation of spatially diverse, terrestrial-satellite communications systems operating at high frequencies.

Gradišek Co-author of a Monograph on Bumblebees

In the monograph »Črmlji v Sloveniji« on characteristics, distribution, species, viruses, pollination, published by the museums of the Municipality of Radovljica in addition to the authors of Assist. Prof Dr Petra Bole, Prof. Dr Janez Grad, Tomaž Oštir and Prof. Dr Ivan Toplak, is also a collaborator of the Departments of Intelligent Systems and Solid State Physics Assist. Prof Dr Anton Gradišek. The book presents different perspectives on the lives of these important pollinators, while Assist. Prof Dr Gradišek describes in his chapters the study of bumblebees with the help of sensors, especially temperature and sound, which were carried out together with colleagues of the Jožef Stefan Institute, Prof. Grad and partners from the USA within two National Geographic projects. Among other things, they developed a method for counting the arrivals and departures of bumblebees from the hive and a method for recognizing the type of bumblebee based on the sound of the buzzing. The introduction to the monograph was written by professor of biology, publicist and beekeeper Janez Gregori. The monograph, which has an abundance of images, also brings a new overview of the species present in Slovenia. Once it was believed that 35 species of bumblebees live in Slovenia, now we know there are 39.

Džeroski, One of the Co-organizers of the First European School on Artificial Intelligence

Ljubljana, July 2023, source: STA

Research on artificial intelligence (AI) in Slovenia began more than 50 years ago at the Jožef Stefan Institute, which still plays one of the most important roles in the field of artificial intelligence research in Slovenia.

Of the eight research departments, three, i.e., more than 150 researchers, are primarily engaged in the study of artificial intelligence.

That is why we proudly followed the first European School on Artificial Intelligence, which took place at the Ljubljana Faculty of Computer and Information Science between 24 and 28 July 2023. Its purpose was to transfer the latest and most important achievements in this field to new generations of young researchers and prepare them for the future.

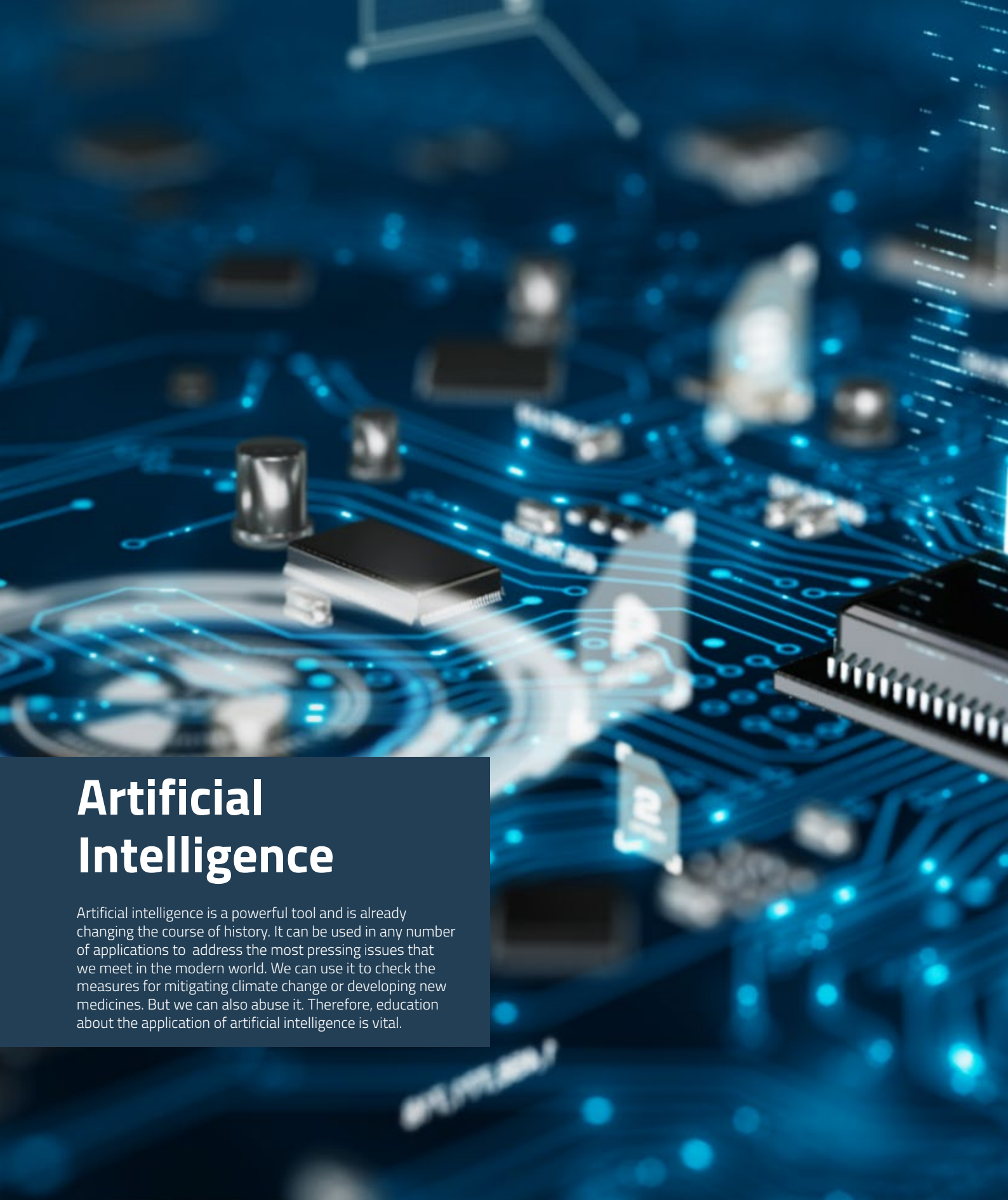
The event, which was attended live by over 570 participants, offered as many as 36 courses that showed all the diversity of artificial intelligence. Courses in planning and investigation, automation of machine learning, large language models, enhanced learning, robotics, impartiality, and equity and privacy in AI were offered, among others.

»Artificial intelligence touches more and more areas of our lives and also our future,« said Sašo Džeroski, head of the programme committee of the Advanced Artificial Intelligence Course. He emphasised that the summer school is an excellent opportunity to exchange knowledge and experience in the field of artificial intelligence and to transfer knowledge to younger generations, which are our future. Part of the school is also an advanced artificial intelligence course on the topic of Artificial Intelligence in Science. According to him, science is of paramount importance, primarily for our society's ability to respond to the challenges it faces, from climate change, food security to public health. »It is therefore crucial that AI helps scientists make meaningful discoveries faster, and this is exactly what the topic of this advanced course on artificial intelligence in science mentioned,« Džeroski explained.

The summer school was held under the auspices of the European Association of Artificial Intelligence (EurAI). In addition to the University of Ljubljana, the Jožef Stefan Institute and the University of Primorska participated in the organization.

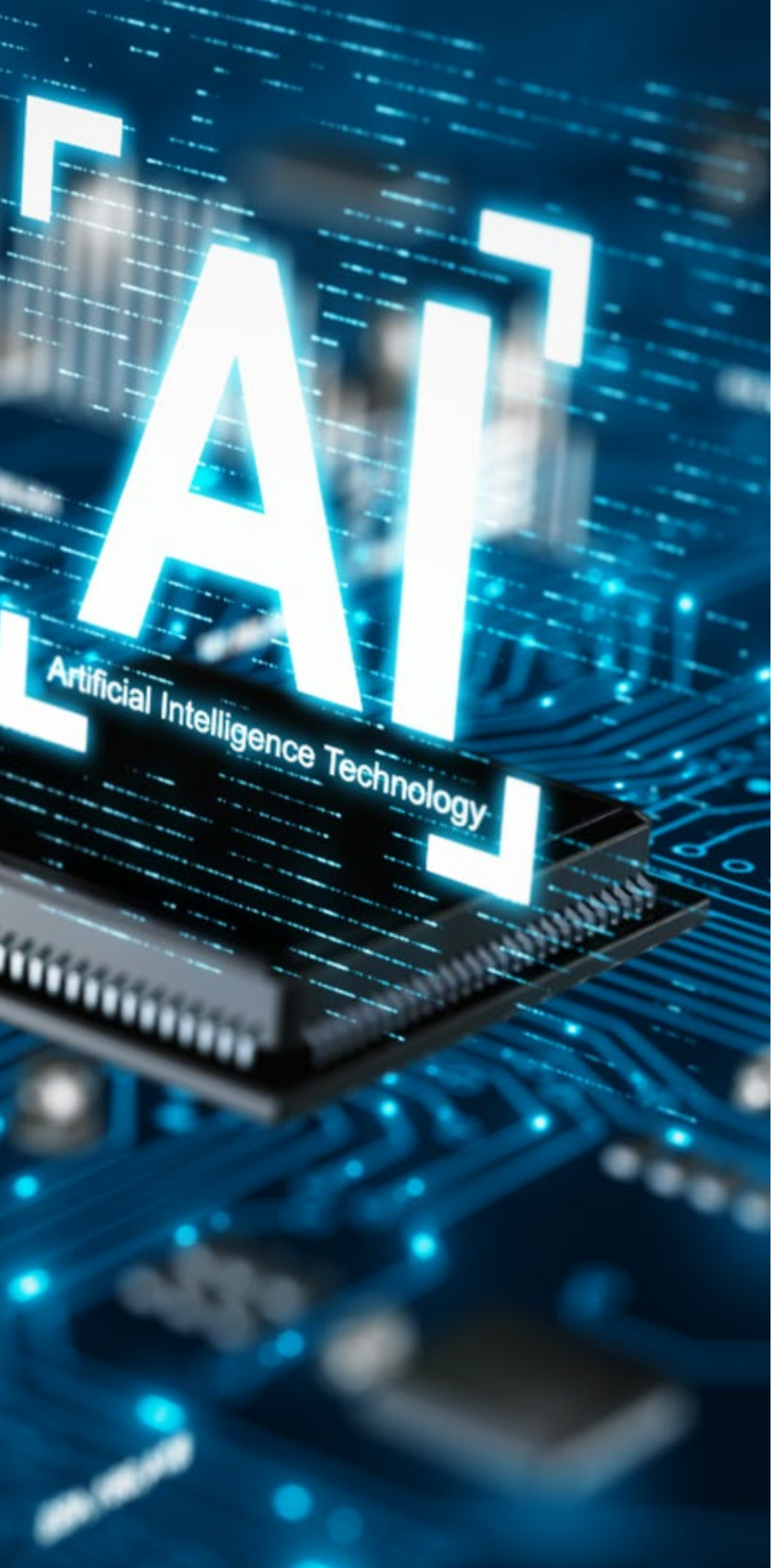
The interest in the summer school was extremely high: over 630 participants from 42 countries from all over the world attended 36 courses that demonstrated all the diversity of artificial intelligence, and as many as 60 top lecturers spent five days passing on their knowledge.


ESSAI & ACAI 2023



Artificial Intelligence

Artificial intelligence is a powerful tool and is already changing the course of history. It can be used in any number of applications to address the most pressing issues that we meet in the modern world. We can use it to check the measures for mitigating climate change or developing new medicines. But we can also abuse it. Therefore, education about the application of artificial intelligence is vital.



We are taking advantage of the potential offered by various artificial intelligence methods, such as machine learning and metaheuristic optimization. Using high-performance computing, we will extract new scientific findings from research data. We will develop advanced methods of comprehensible artificial intelligence and use them to simplify and accelerate the process of discovering new materials based on quantum properties. With these functional materials, we will address the greatest challenges of modern society. With comprehensible artificial intelligence, we will encourage open science and collaboration between human and robotic scientists of the future.

We will explore the interactions between quantum technologies and artificial intelligence, thereby ensuring synergistic effects in the development of the latest materials and medicines, enabling advanced health diagnostics and many other breakthroughs.

Using quantum computing, key AI approaches based on machine learning, and optimization, we will achieve unimagined capabilities critical to AI's success in challenging real-world practical use cases. With the help of artificial intelligence, we will also improve calculation processes in quantum computing.

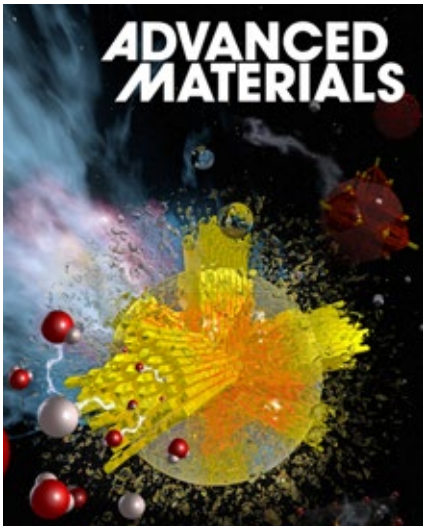
First Example of Dissociative Interaction Between Mineral Surfaces and Water

Journal: **Advanced Materials**

Authors: **Vesna Ribič**, Vanja Jordan, **Sandra Drev**, **Janez Kovač**, Goran Dražić, **Aleksander Rečnik**

Ljubljana, December 2023

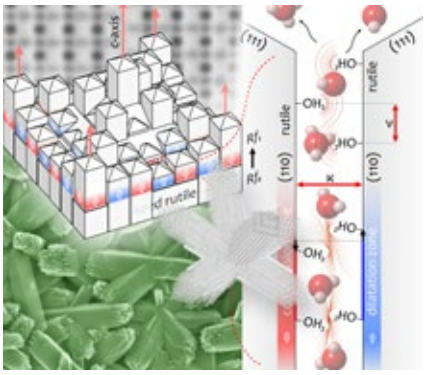
Colleagues led by Prof. Aleksander Rečnik from the Department for Nanostructured Materials at the Jožef Stefan Institute noticed when studying the mechanism of epitaxial growth of rutile fibres that this unusual nanostructured material spontaneously dissociates water. As the authors of the discovery reveal, the secret of this phenomenon lies in the strong surface interactions between rutile and water, which take place in a strictly limited quantum space between fibres in a special structural relationship. This is the first example of the so-called spontaneous dissociative interaction between mineral surfaces and water, which opens up a new direction of research in catalytic water fission to solve the world's growing needs for clean energy.



The combustion of hydrogen is the purest source of energy, since the product of the reaction is water, while releasing a large amount of energy. One way to obtain hydrogen is to dissociate water, which is a reverse chemical reaction in which water is cleaved into hydrogen and oxygen. For example, thermal decomposition of water occurs only at temperatures above 2000 °C, which reflects the extreme energy complexity of this reaction, so hydrogen production in water fission processes now accounts for only 4% of all world production. On the other hand, in nature we know the process of photosynthesis, where the splitting of water with slightly different products takes place already under atmospheric conditions. This raises the question that scientists have been working on for more than 50 years, namely whether an effective catalytic process can be found, the product of which would be hydrogen.

How did the discovery come about? The beginnings of research date back to 2014, when doctoral candidate Vanja Jordan under the mentorship of Prof. Aleksander Rečnik at the Department of Nanostructured Materials began studying the self-regulation and growth of rutile fibres from hydrothermal solutions. In a series of syntheses with which she tried to induce doubling on rutile crystals, she acquired unusual fibred structures, which became of great interest due to their unexpected structural translation. There was no wise explanation for delays between fibres until four years later when Dr Vesna Ribić from the University of Belgrade, who began systematic modelling and quantum chemical calculations of hydroxylization of surfaces and proton-transfer mechanisms, joined the study and then a final solution was arrived at that responded to the observed structural delays between fibres. Moreover, it has been shown that the water present between such fibres with lags spontaneously dissociates, while on the fibres without delays it remains inert. Thus, our scientists were the first in the world to use quantum-chemical calculations to show an undoubted link between

structural translation between fibres and water dissociation, which is the first solid step in the development of the process of splitting water along the catalytic route. The work was also assisted by Dr Janez Kovač from the Department of Surface Technology and Optoelectronics, Dr Sandra Drev from the Centre for Electron Microscopy and Microanalysis, and Prof. Goran Dražić from the National Institute of Chemistry, who each with their own expertise significantly contributed to understanding the surface properties and structural translation of rutile fibres.
Recognizing the importance of the discovery, the authors sent their research for publication to one of the most prestigious scientific journals in the field of materials by Wiley's publishing house. The editorial board of the journal realized the importance of the discovery and immediately sent the manuscript of the article for review to leading scientists in the field of water fission, who in their reviews evaluated the article extremely well and proposed some additional measurements that confirmed the predicted functionality of the material. The article entitled Mnemonic Rutile–rutile Interfaces Triggering Spontaneous Dissociation of Water was included in the category Editor's choice and Hot topic in the field of photocatalytic water breakdown. The work is entirely the result of research by Slovenian scientists.



Dušan Turk and an International Group Publish in Science

Journal: **Science**

Authors: Nina-Eleni Christou, Virginia Apostolopoulou Diogo V. M. Melo, Matthias Ruppert, Alisia Fadini, Alessandra Henkel, Janina Sprenger, Dominik Oberthuer, Sebastian Günther, Anastasios Pateras, Aida Rahmani Mashhou, Oleksandr M. Yefanov, Marina Galchenkova, Patrick Y. A. Reinke, Viviane Kremling, T. Emilie S. Scheer, Esther R. Lange, Philipp Middendorf, Robin Schubert, Elke De Zitter, Koya Lumbao-Conradson, Jonathan Herrmann, Simin Rahighi, Ajda Kunavar, Emma V. Beale, John H. Beale, Claudio Cirelli, Philip J. M. Johnson, Florian Dworkowski, Dmitry Ozerov, Quentin Bertrand, Maximilian Wranik, Camila Bacellar, Saša Bajt, Soichi Wakatsuki, Jonas A. Sellberg, Nils Huse, **Dušan Turk**, Henry N. Chapman, Thomas J. Lan

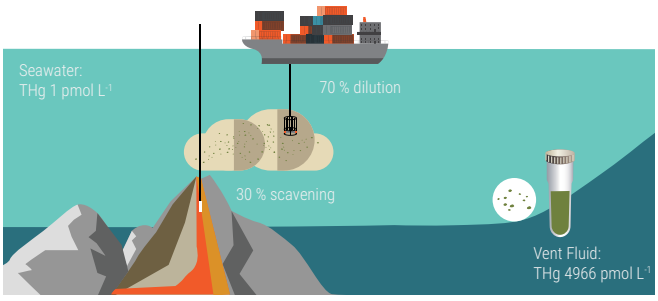
A major international group of authors published an article entitled Time-Resolved Crystallography captures Light-Driven DNA Repair, in which it showed how the enzyme photolyase effectively directs sunlight energy to repair damaged DNA. Slovenian researchers Prof. Dr Dušan Turk from the Jožef Stefan Institute and the Centre of Excellence CIPKeBiP, and Ajda Kunavar, an associate at the National Institute of Chemistry and a doctoral student at the Faculty of Mechanical Engineering, University of Ljubljana, also participated in the group led by the German electronic synchrotron DESY and Universität Hamburg. The article was published simultaneously with the paper Visualizing the DNA Repair Process by a Photolyase at Atomic Resolution in the most prestigious scientific journal Science.
Living beings must cope with DNA damage caused by UV rays. Such damage can cause defects in the genetic code and lead to mutagenesis and potentially to cell death. For survival, organisms have therefore developed various DNA repair mechanisms. One such mechanism is photolysis. Photolyase is an enzyme that specifically recognizes and binds two sequential and transversely linked thymine residues in the DNA chain, then absorbs sunlight of shorter wavelengths (blue) and uses it to break the transverse bonds and restore DNA to its original form.
Over past decades, researchers have studied whether, during DNA repair, double bonds between carbon atoms of two neighbouring thymine residues are cleaved simultaneously or sequentially. Using time-resolution crystallography, they now gained insight into the state sequence between 3 ps to 10 micro seconds and revealed that one bond is broken first and only then the other, and then the repaired DNA chain is squeezed out of the active site. The study also showed that the enzyme has an active site that matches the form of damaged DNA, but cannot bind to undamaged or repaired DNA.

Use of Fluids in Gas-Jet Springs, Seawater and Stone Samples in a New Study

Journal: **Nature Geosciences**

Authors: Natalia Torres-Rodriguez, Jingjing Yuan, Sven Petersen, Aurélie Dufour, David González-Santana, Valérie Chavagnac, Hélène Planquette, **Milena Horvat**, David Amouroux, Cécile Cathalot, Ewan Pelleter, Ruoyu Sun, Jeroen E. Sonke, George W. Luther, Lars-Eric Heimbürger-Boavida

Within the framework of the EU MSCA ITN GMOS-Train project, coordinated by Prof. Milena Horvat from the Department of Environmental Sciences at the Jožef Stefan Institute, they published some interesting research that is available in Nature Geosciences. The study is particularly important because the new research used measurements of fluids in a gas-jet spring, seawater, and stone samples from the Trans-Atlantic Geotraverse (TAG) hydrothermal source on the Mid-Atlantic Ridge. Samples were collected during special GEOTRACES and IODP expeditions. Joint observations show that most of the mercury enriched in the spring fluids is diluted in the seawater and only a small fraction is locally cleaned. Extrapolation of results suggests that global hydrothermal mercury flow from mid-ocean ridges is small (1.5–65 tonnes annually) compared to anthropogenic mercury emissions. While this suggests that most of the mercury in the ocean is of anthropogenic origin, it also gives us hope that the strict implementation of emission reductions under the Minamata Convention will reduce mercury levels in fish and humans' exposure to this metal.

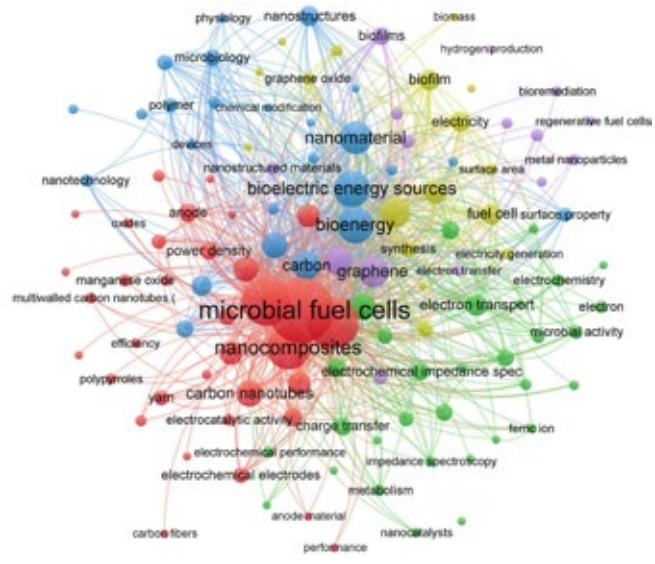


Microbial Fuel Cells as New Energy Sources

Journal: **Renewable and Sustainable Energy Reviews**

Authors: **Raghuraj Singh Chouhan**, Sonu Gandhi, Suresh K. Verma, Ivan Jerman, Syed Baker, **Marko Štrok**

Dr Raghuraj Singh Chouhan and Dr Marko Štrok from the Department of Environmental Sciences at the Jožef Stefan Institute, in cooperation with Dr Ivan Jerman from the National Institute of Chemistry and colleagues from abroad, published the article Recent Advancements in the Development of Two-Dimensional Nanostructured-based Anode Materials for Stable Power Density in Microbial Fuel Cells in the journal Renewable and Sustainable Energy Reviews. The work focuses on various aspects of microbial fuel cells (MFCs), which represent new energy sources with unique properties for many applications as they generate power using exoelectrogens that form a biofilm on the surface of the anode. The paper presents current research perspectives with a comprehensive summary of recent developments in the MFC field, including the use of carbon nanotubes, graphene, graphite carbon nitride, MXene and their nanocomposites as anode materials, challenges and future perspectives regarding the development of MFC anode materials, and ends with general conclusions regarding MFC research.



New Mechanism Associated with Mutation in the C9orf72 Gene Discovered

Journal: **Nature Communications**

Authors: **Mirjana Malnar Črnigoj**, **Urša Čerček**, Xiaoke Yin, Manh Tin Ho, Barbka Repič Lampret, Manuela Neumann, Andreas Hermann, Guy Rouleau, Beat Suter, Manuel Mayr, **Boris Rogelj**

Ljubljana, October 2023

This time we are reporting on the success of scientists researching the causes of frontotemporal dementia (FTD) and amyotrophic lateral sclerosis (ALS). In the latest study, an international team of researchers from Slovenia, Germany, Great Britain and Canada discovered a new mechanism associated with the C9orf72 mutation in a paper published in the prestigious journal Nature Communications. The findings further reveal the causes of the disease, while allowing the development of new strategies for treatment.

Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disease that results in the decay of motor neurons in the spinal cord, brain stem and primary motor cortex and causes reduced muscle function. Frontotemporal dementia (FTD) is a disease with similar characteristics and is the second-most common dementia occurring before the age of 65. Different genes are associated with their development, the most common of which is the C9orf72 gene, in which a change in DNA notation causes the formation of long RNA repetitions that contribute to the development of the disease. The length of recurrences is usually 2 to 30 in healthy individuals and just over 10 to thousands of recurrences in ALS and FTD patients.

In the latest research, researchers found that part of the RNA repetitions generated by the mutation are abnormally associated with the protein FARSA, leading to cell dysfunction. Protein FARSA in healthy cells ensures that the amino acid phenylalanine is correctly attached to the portable tRNA molecule, which delivers the amino acid to the protein-formation process. To observe the interaction between RNA replications and proteins, a new method has been developed that allows scientists to observe such interactions throughout the cell, something which has been difficult so far. This is an unusual association of RNA repetitions – the FARSA protein causes a decrease in amino acid attachment, which leads to abnormalities in the formation of phenylalanine-rich proteins and consequently a reduced amount of them.

The newly discovered interaction and mechanism leading to the development of ALS and FTD can make an important contribution to further research into an area that has been poorly researched so far and to the development of new treatment strategies for patients with the C9orf72 mutation.

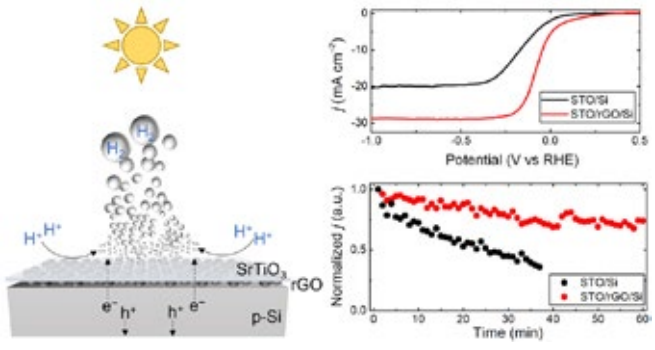
The research was carried out by young researcher Urša Čerček and researcher Dr Mirjana Malnar Černigoj, led by Prof. Dr Boris Rogelj from the Department of Biotechnology at the Jožef Stefan Institute and the Faculty of Chemistry and Chemical Technology of the University of Ljubljana in cooperation with Barbka Repič Lampret from the University Medical Centre Ljubljana and researchers from Germany, Great Britain and Canada. Prof. Dr Boris Rogelj from the Jožef Stefan Institute said: »This year we managed to publish two articles, in addition to Nature Communications, also in the journal Brain. Both refer to different forms of neurodegenerative diseases, but will attract international attention from researchers in our field because they open up new aspects of the mechanisms of disease formation and consequently new targets for therapeutic approaches. Behind the publications in both Brain and Nature Communications there are several years of tremendous effort and ingenuity from the researchers involved. The time dynamics and the fact that we have managed two publications in one year in prestigious journals are surprising, and in the scientific process such events sometimes just fall into place.«

With a Simple Approach to Effective Corrosion Protection

Journal: **ACS Applied Materials & Interfaces**

Authors: **Hsin-ChiaHo**, Milutin Smiljanić, Zoran Jovanović, **Miha Čekada**, **Janez Kovač**, Gertjan Koster, Jiří Hlinka, Nejc Hodnik, **Matjaž Spreitzer**

The generation and conversion of solar energy into hydrogen fuel is mainly based on efficient and stable materials. Prof. Dr Matjaž Spreitzer and Dr Hsin-Chia Ho from the Department for Research of Advanced Materials, Prof. Dr Miha Čekada from the Department for Thin FIlms and Surfaces and Prof. Dr Janez Kovač from the Department of Surface Technology and Optoelectronics at the Jožef Stefan Institute showed that with a simple approach, a high-performance photo-absorber, a silicon substrate, can be effectively protected from corrosion with a robust layer of strontium titanate ($SrTiO_3$) during photoelectrochemical reactions of water fission. In cooperation with the National Institute of Chemistry and the Institute of Physics of the Czech Academy of Sciences, the results were published in the journal ACS Applied Materials & Interfaces. Research has shown that by applying an intermediate layer of reduced graphene oxide (rGO) on a silicon substrate, the crystallinity and morphology of the $SrTiO_3$ protective layer can be adjusted accordingly, so that the durability of the silicon substrate and its photoelectrochemical capacity are greatly improved, depending on the properties of individual components.

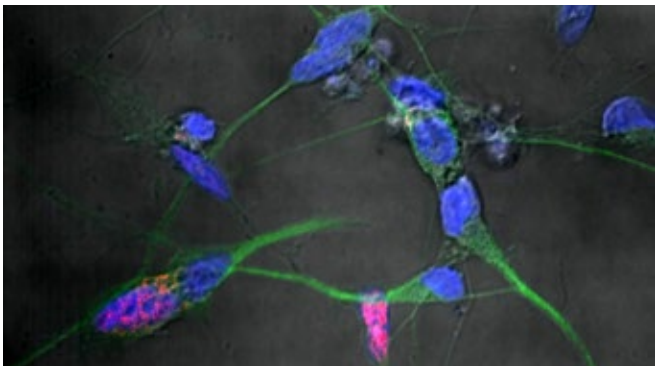


Rogelj, Motaln and Čerček Discover a New Modification of the Protein FUS

Journal: **Brain**

Authors: **Helena Motaln**, **Urša Čerček**, Alfred Yamoah, Priyanka Tripathi, Eleonora Aronica, Anand Goswami, **Boris Rogelj**

Researchers of the Department of Biotechnology at the Jožef Stefan Institute, Prof. Dr Boris Rogelj, assist. Dr Helena Motaln and young researcher Urša Čerček, together with colleagues from Germany and the Netherlands discovered a change in the protein FUS, which is involved in the early development of frontotemporal dementia disease (FTD). The researchers developed a specific detector (antibody) for the phosphorylated last amino acid of the protein FUS and revealed using advanced microscopy a pattern of distribution of soluble and insoluble FUS protein in cells that could not be detected by commercially available detectors known so far. They managed to evaluate in more detail the effect of phosphorylation of FUS by enzymes Src, Fyn and Abl on the distribution of FUS in neurons of the anterior cortex of the brain. They found that under stress conditions, the enzyme Abl is actively involved in the misallocation of FUS protein in nerve cells, which was given as a new basic mechanism for the formation and progression of the FUS-FTD disease. The results of the research provide new insights into the causes of FTD and the development of new strategies for treating the disease.

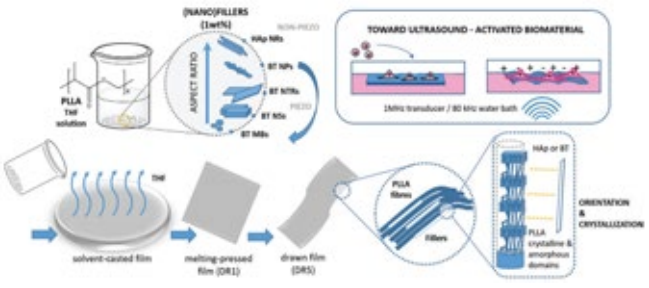


Openly Effective Approach to the Design of Properties for Organic Piezoelectric Biomaterials

Journal: **Small**

Authors: **Marija Vukomanović**, **Lea Gazvoda**, **Mario Kurtjak**, **Marjeta Maček-Kržmanc**, **Matjaž Spreitzer**, Qiao Tang, Jiang Wu, Hao Ye, Xiangzhong Chen, Michele Mattera, Josep Puigmartí-Luis, Salvador Vidal Pane

Researchers of the Department for Advanced Materials at the Jožef Stefan Institute Assist Prof Ddr Marija Vukomanović, Mag. Lea Gazvoda, Dr Mario Kurtjak, Dr Marjeta Maček-Kržmanc and Prof. Dr Matjaž Spreitzer, together with colleagues from the Institute of Robotics and Intelligent Systems (IRIS) at ETH Zurich in Switzerland and the Institute of Theoretical and Computational Chemistry of the University of Barcelona, Spain, discovered and published in the Wiley journal Small (IF=15) that the addition of a small fraction of crystalline particles with highly anisotropic forms to a polymer matrix is a very effective approach for designing the properties of organic piezoelectric biomaterials such as poly(L-lactide), including crystallisation, orientation and piezoelectricity, and their interactions with human cells. From an applied point of view, piezoelectric PLLA has great potential for designing an advanced tool for use in bioelectronics. The possibility of optimizing electrical properties with an impact on polymer crystallization is an interesting approach to adapt the biomaterial to the regenerative needs of various tissues.

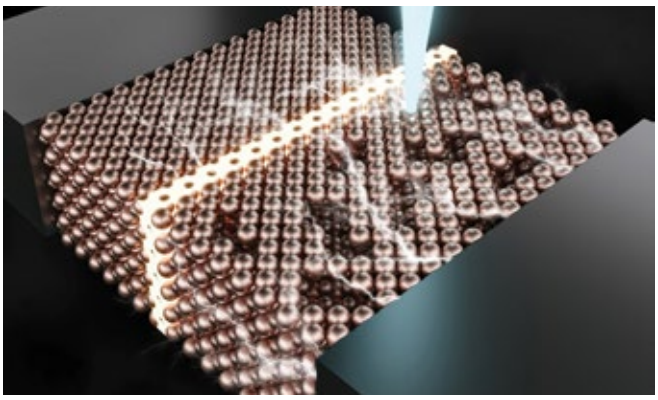


New Insights Into Dynamic, Atomistic Processes on Domain Walls in Ferroelectric Materials

Journal: **Nanoletters**

Authors: **Oana Condurache**, **Goran Dražić**, **Tadej Rojac**, **Hana Uršič**, Brahim Dkhil, Andraž Bradeško, Dragan Damjanovič, **Andreja Benčan**

Colleagues from the Electronic Ceramics Department of the Jožef Stefan Institute, Oana Condurache, Prof. Dr Goran Dražić, Prof. Dr Tadej Rojac, Prof. Dr Hana Uršič and Prof. Dr Andreja Benčan, in cooperation with researchers from the National Institute of Chemistry, the Ecole Polytechnique Fédérale de Lausanne and the Université Paris-Saclay, published a study entitled Atomic-Level Response of the Domain Walls in Bismuth Ferrite in a Sub-Coercive-Field Regime. In the paper, using in-situ scanning electron microscopy, researchers studied the dynamics of domain walls and defects in bismuth ferrite under an electric field. The dynamics of the domain walls in the presence of defects reveal unique and complex phenomena at the atomic level. In the paper, the authors report on the segregation of defects, changes in local voltages, and the redistribution of charge on domain walls when changing the electric field. The results of the study contribute to an insight into dynamic, atomistic processes on domain walls in ferroelectric materials. The publication of the article was accompanied by a journal cover developed by the authors.

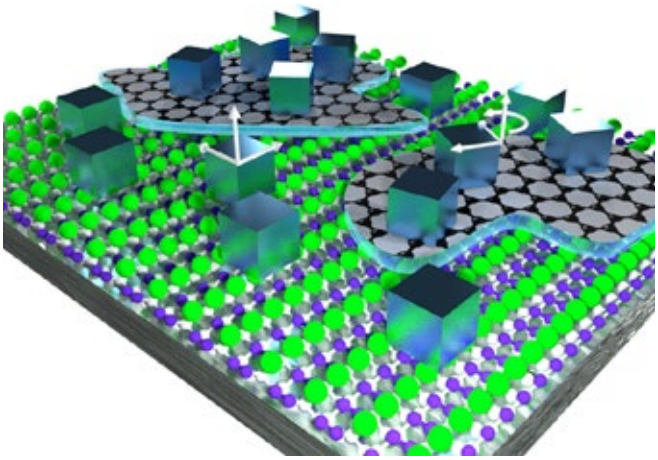


Promising New way to Integrate Materials with Different Properties

Journal: **ACS Applied Materials & Interfaces**

Authors: **Zoran Jovanović**, **Urška Trstenjak**, **Hsin-Chia Ho**, Olena Butsyk, Binbin Chen, Elena Tchernychova, Fedir Borodavka, Gertjan Koster, Jirí Hlinka, **Matjaž Spreitzer**

The journal ACS Applied Materials & Interfaces published a study carried out by colleagues from the Department for Advanced Materials, Prof. Dr Matjaž Spreitzer, Dr Zoran Jovanović, Dr Urška Trstenjak and Dr Hsin-Chia Ho, in cooperation with researchers from the National Institute of Chemistry, the Institute of Physics of the Czech Academy of Science and the MESA+ Institute of Nanotechnology of the University of Twente. The article presents the design and results of a hybrid approach that provides a unique perspective for the integration of functional oxides with a silicon platform. The approach also enables direct and van der Waals epitaxis oxides for the preparation of high-quality, pseudo-substrates for the further synthesis of functional oxides for use in electronics. The key step is to maintain the quality of 2D materials during and after their transfer to the desired base. Given that the quality of such layers prepared on reduced graphene oxide is comparable to significantly more expensive and complex preparation processes, this approach represents a promising new way to integrate materials with different properties.

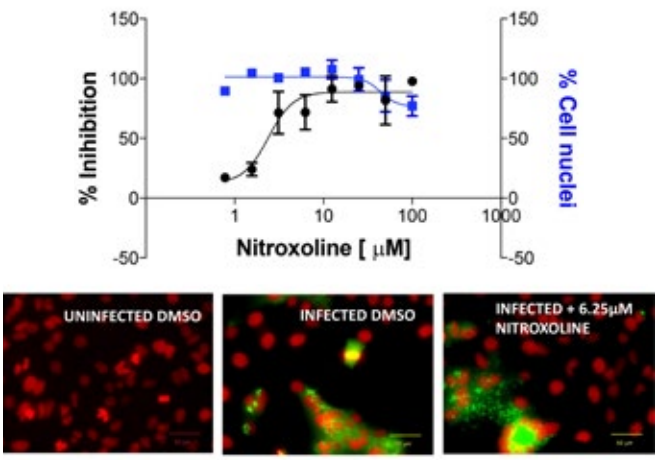


Important Role of Cathepsin B Identified

Journal: **Antiviral Research**

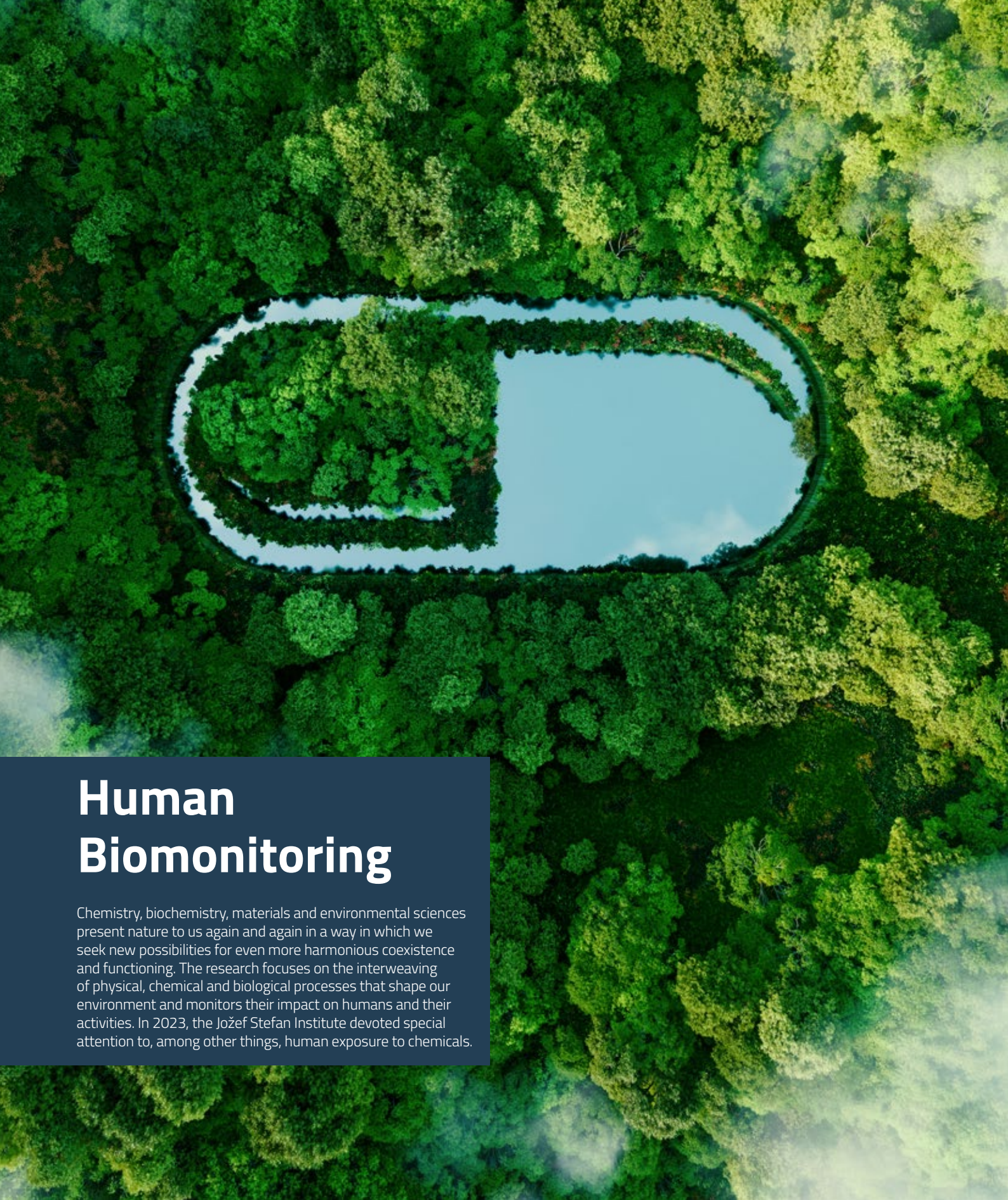
Authors: Rafaela Milan Bonotto, **Ana Mitrović**, Izidor Sosi, Pamela Martínez-Orellana, Federica Dattola, Stanislav Gobec, **Janko Kos**, Alessandro Marcello

The severity of the SARS-CoV-2 pandemic and the repeated (re-) emergence of viruses have encouraged the development of new therapeutic approaches. Members of the Department of Biotechnology at the Jožef Stefan Institute, assist. Dr Ana Mitrović and Prof. Dr Janko Kos, in cooperation with researchers from the Faculty of Pharmacy, University of Ljubljana and the International Centre for Genetic Engineering and Biotechnology ICGEB from Trieste, published an article Cathepsin Inhibitors Nitroxoline and its Derivatives Inhibit SARS-CoV-2 Infection in the journal Antiviral Research (IF = 10,103). In the paper, they showed that selective cathepsin B inhibitors nitroxoline and its derivatives reduce SARS-CoV-2 infection. They further showed that the antiviral activity of inhibitors is dependent on cell type, it is associated with intracellular expression and the activity of cathepsins B and L. The results obtained thus highlight the important role of cathepsin B in host cells in the entry of the SARS-CoV-2 virus and suggest that cathepsin-B inhibitors such as nitroxoline and its derivatives could be used to treat COVID-19.



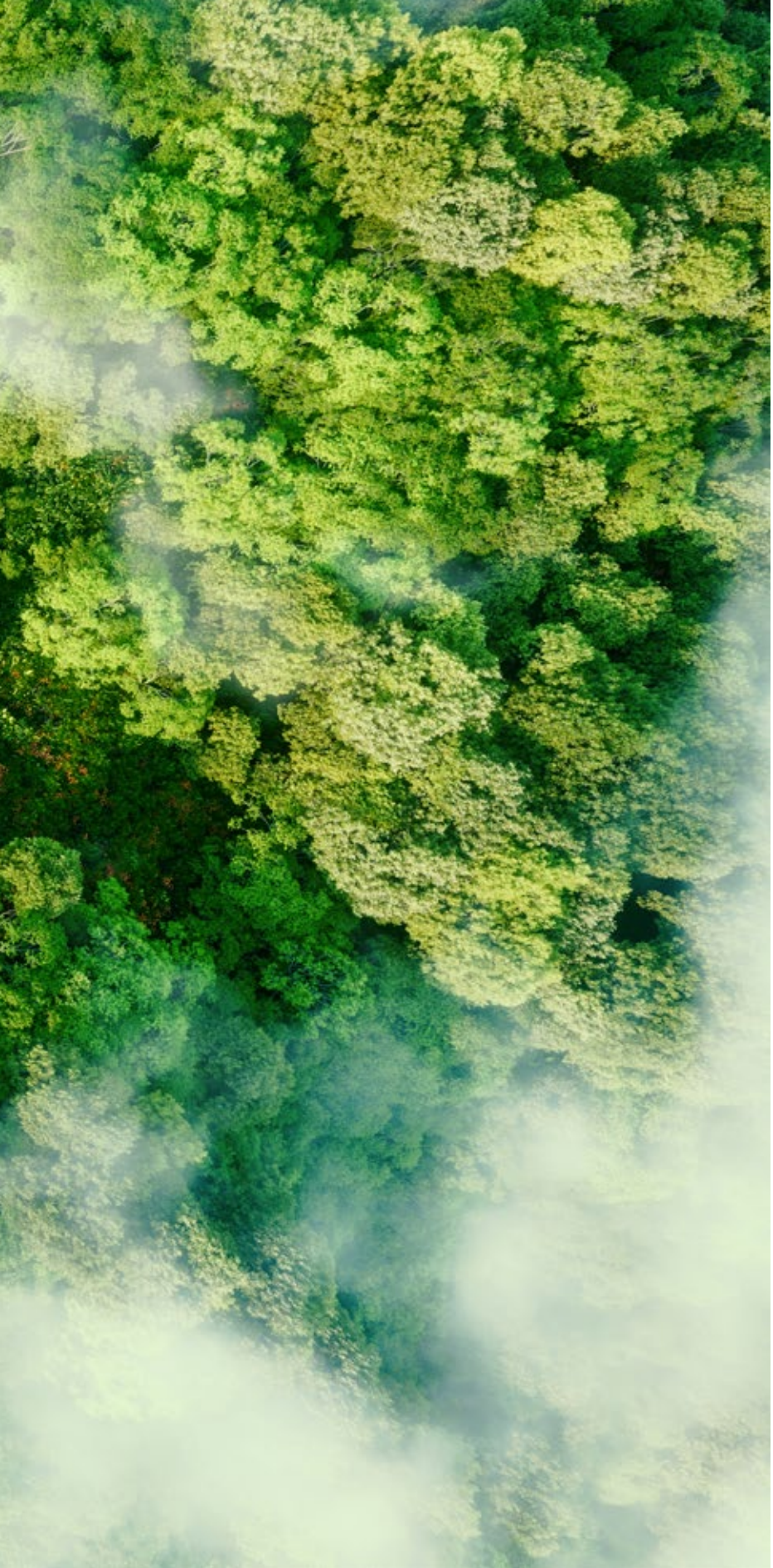
The ISOFOOD Symposium – a Key Event in the Field of Food Safety Studies

The ERA Chair ISOFOOD at the Department of Environmental Sciences organized the ISOFOOD symposium in April 2023, which represents a key event in the field of food safety studies. The organization of such symposia enables scientists, researchers, decision-makers and other stakeholders to meet, exchange ideas and present the latest developments in isotopic and chemical methods related to food safety, quality and authenticity. The focus on authenticity and quality is especially important today, when we are faced with many challenges regarding food safety and the fair labelling of products. The symposium allows experts to discuss these topics, share best practices and develop new methods to ensure safe and high-quality food. The participation of 120 participants from 17 different countries in Europe and the rest of the world underlines the international importance of the ISOFOOD symposium. This broad participation enables a rich exchange of ideas and information and promotes global cooperation in solving food safety and quality challenges.



Human Biomonitoring

Chemistry, biochemistry, materials and environmental sciences present nature to us again and again in a way in which we seek new possibilities for even more harmonious coexistence and functioning. The research focuses on the interweaving of physical, chemical and biological processes that shape our environment and monitors their impact on humans and their activities. In 2023, the Jožef Stefan Institute devoted special attention to, among other things, human exposure to chemicals.



Slovenia is one of the few European countries that has legislated for the biomonitoring of chemicals. With human biomonitoring (HBM), we obtain data on the scope and amount of human exposure to chemicals. Tracking exposure is very important because many chemicals have negative effects on human health. The conventional approach allows for the tracking of pre-selected chemicals with proven adverse effects, but excludes those about which we know less, even if they might be more dangerous to health. In order to overcome this shortcoming, researchers from the Department of Environmental Sciences focused their research on the development of an analytical methodology that will enable the comprehensive tracking of exposure to known (as well as yet unknown) chemicals. As a proof of concept, the urine of Slovenian children was analysed, and 74 biomarkers of exposure were determined. This showed that humans are exposed to expected chemicals, as well as to those that have not been reported so far. The results show the large scale of children's exposure, including to chemicals that pose a serious threat to health. Our results can serve as a basis for the development of intervention measures to reduce the impact of chemicals on health. The achievement is therefore important for the development of human biomonitoring, and contributes to informing public health. The contribution of this work is the development and application of a new analysis methodology in human biomonitoring, with which, at the Jožef Stefan Institute, we discovered 74 biomarkers of exposure in the urine of Slovenian children. The achievement highlights the extent of children's exposure to mixtures of known and unknown chemicals. Many of them can represent an important risk factor for children's health.

AWARDS AND RECOGNITIONS

Total
122
awards

38	47	5	27	5
Zois awards	Zois prizes	Puh awards	Puh prizes	Ambassadors of science
18 % 82 %	26 % 74 %	20 % 80 %	11 % 89 %	40 % 60 %

***Data are for the period 2000–2023

In their work, researchers are mostly looking for answers to new questions. When the answers are found, they tend to be not completely satisfactory, and so new questions arise. Or, as the former director of the Jožef Stefan Institute and the winner of the Zois Lifetime Achievement Award in 2023, Prof. Dr Danilo Zavrtanik, said in an interview for newspaper Delo: »The feelings we have, when we discover something new, make it all worthwhile.« It seems that the flow of research from total ignorance to an objectively recognized solution is sufficient. Nevertheless, moments of recognition and praise are also special in science. And in 2023, many colleagues at the Jožef Stefan Institute experienced such moments.

Zois Awards for JSI

Ljubljana, November 2023

On 28 November 2023, at Cankarjev Dom in Ljubljana, there was a presentation of the highest national awards in the field of science. Among the winners of these awards and recognitions were three employees of the Jožef Stefan Institute. The long-time collaborator of the Jožef Stefan Institute and the director between 1992 and 1996 Prof. Dr Danilo Zavrtanik received the Zois Lifetime Achievement Award for outstanding research results in various subfields of high-energy physics.

The Zois Award for outstanding achievements in the field of toxinology was awarded to the Head of the Department of Molecular and Biomedical Sciences, Prof. Dr Igor Križaj. In addition to the numerous achievements of Prof. Dr Igor Križaj, two stand out in particular, bringing a conceptual breakthrough in the treatment of two of the most pressing diseases in the world today – Alzheimer's disease and venous thromboembolism. »When I received the news that I would be one of this year's recipients of the Zois Award for outstanding scientific research achievements, I was first shocked, then immensely happy, and with distance, I am increasingly overwhelmed by pride and gratitude. This award is a remarkable recognition of the discoveries we made under my leadership with colleagues from the Department of Molecular and Biomedical Sciences. Many external, domestic and foreign research partners, as well as my master's and doctoral students, also contributed important pieces to this mosaic of success. This high recognition is a confirmation that we have done well and is a great motivation to work in the future. With even greater enthusiasm, I will strive for the results of our work to contribute to solving the key health challenges of our time, managing cardiovascular complications and dementias that we focus on in our research,« said Prof. Dr Igor Križaj, upon receiving the Zois Award.

The Zois Award for important achievements in the field of plasma physics was given to the Head of the Department of Gaseous Electronics, Prof. Dr Uroš Cvelbar, who achieved a major breakthrough in the understanding and use of gas discharges. Together with colleagues at the Jožef Stefan Institute and external partners, he successfully worked in the field of understanding cold plasmas at atmospheric pressure, explaining the phenomenon of the electric wind, using plasma-generated electrodynamic force to stabilize fluid instability, using plasma to build new nanomaterials and cleaning surfaces contaminated with natural toxins. »I regard the award as a great honour, and I accepted it with gratitude. It is an acknowledgment that the research work carried out with enthusiasm at the department is not only important, but also leaves a lasting mark on the scientific and social environment. All these results would not have been possible without the committed work of the team, especially the young scientists who are by my side. This recognition is also an incentive for all of us to continue to pursue excellence in our research work,« said Prof. Dr Uroš Cvelbar upon receiving the Zois Award.

Marath Santosh, Filipić and Hiti are Recipients of Jožef Stefan Golden Emblems

On 22 March 2023, during the Jožef Stefan Days, the Jožef Stefan Golden Emblems were awarded to researchers at home and abroad with the most prominent doctorates in the field of natural sciences, mathematics, technical and life sciences. The Jožef Stefan Golden Emblem was awarded to Dr Neelakandan Marath Santosh for the success and visibility of his doctoral thesis entitled Plasma Enabled Design of Hybrid Carbon Nanostructures for Energy Storage at the proposal of Prof. Dr Uroš Cvelbar from the Jožef Stefan Institute. Dr Arijana Filipić received the Golden Emblem for the success and visibility of her doctoral thesis entitled Inactivation of Viruses in Water by Cold Atmospheric Plasma at the proposal of Professor Dr David Dobnik from the National Institute of Biology, while Dr Bojan Hiti received the Golden Emblem for the success and visibility of his doctoral thesis entitled Radiant Resistance of CMOS Detectors for Upgrading the ATLAS Detector's Internal Tracker at the proposal of Assist. Prof Dr Igor Mandič from the Jožef Stefan Institute.

Vidmar, Prosen and Fajfer, Winners of the 2023 Blinc Prizes

For the fifth time, the Faculty of Mathematics and Physics of the University of Ljubljana and the Jožef Stefan Institute presented the Blinc Prizes for research and professional work in the field of physics. The Blinc Prize for a Physicist at the Beginning of their Career was awarded to Assoc. Prof. Dr Lev Vidmar, who is undoubtedly one of the leading younger researchers in the field of theoretical solid-state physics. The Blinc Award for outstanding unique achievements in the field of physics was awarded to Prof. Dr Tomaž Prosen. In a discovery published in 2018 in the journal Physical Review Letters, Professor Prosen and his colleagues presented the so-called self-double kicked Ising model, with which it is possible to calculate the spectral correlation or spectral design factor without any assumptions and show a match with the theory of random matrices. The Blinc Lifetime Achievement Award in the field of physics went to Prof. Dr Svjetlana Fajfer, who is one of the leading researchers of processes between elementary particles, especially those that could be sensitive to physics beyond the Standard Model. We sincerely congratulate all the winners.

Križan Becomes an Academician of the Slovenian Academy of Sciences and Arts

On 29 June 2023, the SAZU Hall hosted the award ceremony of diplomas to new members of the Slovenian Academy of Sciences and Arts elected at the Electoral Assembly on 1 June. Prof. Dr Peter Križan, an associate of the Department of Experimental Particle Physics at the Jožef Stefan Institute, was also promoted to a regular member in the Class for Mathematical, Physical, Chemical and Technical Sciences. The scientific work of Prof. Peter Križan belongs to the field of experimental physics of elementary particles. In recent years, under his leadership, the preparation of the new Belle II spectrometer has been completed and the first measurements have been made. In 2020, he managed to obtain a prestigious ERC Advanced Grant in the field of elementary-particle physics, and in 2022 an ERC Proof of Concept Grant to develop a new type of medical imaging detector. His bibliography comprises 789 scientific papers, which have been cited 23,851 times. He was also the winner of a Zois Award in 2002 and a Zois Prize in 2008. A total of 32 new SAZU members were welcomed at the ceremony, including 13 associate, 9 regular and 10 correspondence members.

Cizelj a New Emeritus Member, and Kobe and Mihailović new Full Members of the IAS

On 5 June 2023, the Slovenian Academy of Engineers (IAS) solemnly presented documents to newly elected members at Brdo pri Kranju. Among the most eminent Slovenian and foreign experts in the field of engineering and technology, the IAS welcomed 18 new members - 8 correspondence and 10 associate - and promoted 13 associate members to regular membership. Prof. Dr Leon Cizelj, head of the Reactor Engineering Department of the Jožef Stefan Institute, also became a new associate member of the IAS, and Prof. Dr Spomenka Kobe from the Department of Nanostructural Materials and Prof. Dr Dragan Mihailović, Head of the Department of Complex Matter, also became a new associate member of the IAS. Election as a member of the Academy is a high national and social recognition, since the IAS is the only national academy in Slovenia established by law alongside the Slovenian Academy of Sciences and Arts. The award ceremony for the newly elected members was also attended by the Prime Minister of the Republic of Slovenia, Dr Robert Golob, who himself is a member of the IAS, to which he was admitted in 2018, and Minister Dr Igor Papič.

Tanja Goričanec, L'Oréal-UNESCO Scholarship Winner for Women in Science

This year's winners of the L'Oréal-UNESCO National Programme for Women in Science also include a research assistant at the Reactor Physics Department at the Jožef Stefan Institute, Dr Tanja Goričanec. Tanja Goričanec works in a socially extremely important area of transition to a low-carbon society and advocates the use of available carbon-neutral sources, such as renewable sources and reliable nuclear energy, to achieve carbon neutrality. Tanja is also the president of the Young Generation Network of the Slovenian Society of Nuclear Experts, which brings together young experts from various fields of nuclear technology. As president of the young experts, she is involved in all the activities of the association, including the organization of the Stand Up for Nuclear event, the purpose of which is to raise awareness among the public about the advantages of nuclear energy and its role in nature conservation.

Filipič, Tušar, Vodopija, Cork and Korošec are Recipients of the TARAS Award

At the IRT Industrial Forum in Portorož on 12 June 2023, MAHLE Electric Drives Slovenija d.o.o. and the Jožef Stefan Institute received the TARAS Award for successful cooperation between the economy and the R&D environment in the field of innovation, development and technologies. The subject of the cooperation was the development of an electric motor for power-steering systems in vehicles. The aim was to determine the geometry and material characteristics of engine components in such a way that it met the technical requirements and its cost was minimised. The answer was sought by the researchers of the Department of Intelligent Systems (Bogdan Filipič, Tea Tušar, Aljoša Vodopija and Jordan Cork) and the Department of Computer Systems (Peter Korošec) and found in the simulation and optimization process, the peculiarity of which is the statistical evaluation of solutions by addressing permissible deviations in engine manufacturing. The result is a technically sophisticated and affordable engine that improves the company's competitiveness in the market. Cooperation with the company was established through the intervention of the Center for Technology Transfer and Innovation of the Jožef Stefan Institute in 2022.

Snoj, Mentor of the Year Chosen by the Young Academy Association

The Young Academy Association presented the Mentor of the Year awards for the fourteenth time. The winner in 2022 was Assoc. Prof. Dr Luka Snoj, head of the Reactor Physics Department at the Jožef Stefan Institute. Prof. Snoj's virtue is the promotion of active and good student guidance, while allowing enough research freedom. Prof. Snoj also stands out on the human and personal sides, and in addition to work, he places great importance on the well-being of students and colleagues and emphasizes the importance of rest, vacation and leisure. One of the other five finalists was Prof. Dr Janez Kovač from the Department of Surface Technology and Optoelectronics.

Humar Received University of Ljubljana Plaque as a Mentor of Scientific Work

On 4 October 2023, the University of Ljubljana presented Dr Uroš Seljak Awards for the best scientific articles by students, for the second time. The awards were presented by the Rector of the University of Ljubljana, Prof. Dr Gregor Majdič, Prof. Dr Uroš Seljak and the American-Slovenian Educational Foundation (ASEF). The Dr Uroš Seljak awards, this year they presented three, are intended to promote and support the scientific publications of students in first- and second-cycle study programmes and to encourage the mentoring of students in the Republic of Slovenia. Among the recipients of the award was also Miha Papič for his published scientific work entitled Topological Liquid Crystal Superstructures as Structured Light Lasers. He conducted research at the Department of Solid State Physics at the Jožef Stefan Institute, and his mentor, Dr Matjaž Humar, Head of the Laboratory for Biointegrated Photonics and an associate of the Department of Solid State Physics at the Jožef Stefan Institute, also received a plaque for mentoring.

Saša Novak Receiving the Honorary Title of Communicator of Science

In 2023, the recipient of the honorary title Communicator of Science, awarded by the Slovenian Science Foundation, was Prof. Dr Saša Novak, an associate of the Department of Nanostructured Materials at the Jožef Stefan Institute and the Jožef Stefan International Postgraduate School. Dr Novak is the initiator and coordinator of the Science on the Street project, with which researchers, including colleagues at the Jožef Stefan Institute, have been contributing to improving public understanding of science for 10 years by presenting scientific research in public lectures, scientific slams, round tables, scientific blogs and competitions. In addition to professional Slovenian researchers, journalists also participate in the project, which contributes to an interesting and wider circle of people presenting scientific discoveries and findings. Saša Novak herself is the author of dozens of popular science articles published in Slovenian and foreign media. She is also passionate about sharing her knowledge with younger generations of researchers and encouraging them to actively communicate their research work.

Article by Researchers from the Electronic Ceramics Department Win Edward C. Henry Award

The article entitled Dynamics of Domain Walls in Ferroelectrics and Relaxors, recently published in the Journal of the American Ceramic Society by Mojca Otoničar, Mirela Dragomir and Tadej Rojac from the Electronic Ceramics Department of the Jožef Stefan Institute, was selected for the Edward C. Henry Award in 2023. Each year, the award is presented for an outstanding electronic ceramics contribution published in the Journal of the American Ceramic Society or to the American Ceramic Society Bulletin. This year's award-winning article reports on the results of the research activities of the laboratory, which are aimed at understanding the origin of piezoelectric responses of selected ferroelectric and relaxor ceramic materials. The emphasis is on the dynamics and structural aspects of domain walls, which with their dynamics have a pronounced impact on the electrical and electromechanical properties of these technologically important materials. The cover of the journal, in which the paper is published, was created by the authors of the article in collaboration with Mito Gegič, who is one of the more recognizable Slovenian visual artists.

Krka Awards for Research Work

On September 22, 2023, Krka presented its 53rd awards for student research. No less than seven of these projects were carried out at the Jožef Stefan Institute. Krka's awards went to: Katja Mariniko, Luka Bonin and Jan Hafner Korošec (mentor: Marko Jeran, Department of Inorganic Chemistry and Technology), Ela Podboršek and Tim Strnad, Mija Kapun and Daniil Gainullov (mentor: Dr Peter Rodič, Department of Physical and Organic Chemistry) and Nika Kadunc (mentors: Dr Zdenka Šlejkovec and Dr Ingrid Falnoga, Department of Environmental Sciences). Krka's awards went to the tasks of authors Lana Traven (mentor: Dr Darja Lisjak, Department of Materials Synthesis) and Jan Kastelec, Jakob Auersperger and Lara Kalin (mentor: Dr Kostja Makarovič, Department of Electronic Ceramics). The award ceremony was preceded by a scientific symposium where the results of the research work were presented by Katja Marinko, Luka Bonin & Jan Hafner Korošec and Nika Kadunc.

On October 20, 2023, Krka awarded its 53rd awards for undergraduate and postgraduate research theses as an incentive for young researchers to be creative in research & development. Krka's awards were received by four employees of the Jožef Stefan Institute: Evelin Gruden, Sebastjan Nemec, Jan Jelen and Tina Černič. Dr Evelin Gruden from the Department of Inorganic Chemistry and Technology received the award for her doctoral thesis Discrete Aluminium Compounds – Towards Soluble Aluminium Trifluoride under the mentorship of Asst. Prof. Dr Gašper Tavčar. Dr Sebastjan Nemec received the Krka Award for his doctoral dissertation Development of anisotropic magnetic nanoparticles and their magnetic-mechanical effects in biomedicine, under the mentorship of assist. Dr Slavko Kralj. Krka's master's thesis awards went to Jan Jelen under the co-mentorship of Asst. Prof. Dr Gašper Tavčar and Tina Černič under the mentorship of Prof. Dr Darja Lisjak from the Department for Materials Synthesis. Before the ceremony, a scientific symposium was also held, at which Jan Jelen presented his results.

Zupanič and Jeglič Receive the Award for Best Innovation

This year's Best Innovation Awards from public research organizations with the highest market potential were awarded to Assist. Dr Zoran Pučko and Prof. Dr Danijel Rebolj from the University of Maribor for an innovative system for automatic monitoring of constructions and assist. Dr Erik Zupanič and Dr Peter Jeglič from the Jožef Stefan Institute for a new platform for the production of cold atoms for quantum computers and quantum sensors. The innovations were unveiled at 16th International Technology Transfer Conference (ITTC), held this year under the auspices of the European campaign to promote the valorisation of knowledge and the national Month of Science. The valorisation of knowledge was presented by representatives of the European Commission and the domestic innovation ecosystem, as well as by authors from Slovenia and abroad in contributions on technology transfer and intellectual property. The common thought of the participants was that the success of Slovenia's development is based on the valorisation of knowledge in practice, i.e., on the transformation of research and innovation results into social and economic benefits.

Gorišek, ATLAS Detector Control Coordinator

Dr Andrej Gorišek from the Department of Experimental Particle Physics at the Jožef Stefan Institute was elected ATLAS Run Coordinator in the international collaboration ATLAS. Dr Andrej Gorišek will play a key role in guiding a team of hundreds of physicists, engineers and technicians. The hardware and software of the ATLAS experiment, one of two large experiments on the Large Hadron Collider at CERN, were extensively upgraded during a long shutdown between 2019 and 2020, preparing detectors for a new era of data collection called Run 3. In his new leadership role in the international ATLAS collaboration, Dr Andrej Gorišek will act as one of two coordinators responsible for ensuring the efficient operation of the detector and the smooth capture of data from events arising from the collisions of protons and ions accelerated to record energies in the Large Hadron Collider.

VISITS to the Jožef Stefan Institute

As the largest scientific research institution, the Jožef Stefan Institute is always interesting for the public. In 2023, the Institute was visited by more than 1100 schoolchildren, various professionals, representatives of other institutes, universities, companies, politicians, ambassadors and also the President of the Republic of Slovenia, Nataša Pirc Musar. We are aware that in presenting science, which is often considered difficult to understand by society and somewhat distant, the personal experience of each individual is also very important, which is why we are happy to host everyone. And it seems to us that practically everyone is enthusiastic about the Institute, which is an important recognition for us, both for our work and for being on the right path as promoters of science.

President of the Republic of Slovenia, Nataša Pirc Musar, Visits JSI

On 2 June 2023, the Jožef Stefan Institute was visited by the President of the Republic of Slovenia, Nataša Pirc Musar, who, in talks with the management of the institute, was closely acquainted with the functioning of the largest scientific research institution in Slovenia. In addition to the director, Prof. Dr Boštjan Zalar, Prof. Dr Milena Horvat, Prof. Dr Denis Arčon, Prof. Dr Sašo Džeroski and Prof. Ddr Boris Turk presented their fields of activity. The president then visited the Laboratory for Bio-Integrated Photonics, where assist. Dr Matjaž Humar presented his research on lasers in cells, Prof. Dr Miran Čeh presented the latest Spectra 300 scanning electron microscope, while Dr Tadej Petrič and his colleagues showed the President various robots at the Department of Automation, Biocybernetics and Robotics. The researchers and President Nataša Pirc Musar all agreed that such cooperation was very welcome.

The Reactor Visited by Helene Dalli and Marc Angel

As part of a working visit by the EU Equality Commissioner, Helena Dalli, and Marco Angelo, Vice-President of the European Parliament, to Slovenia, accompanied by a delegation of Slovenian and European institutions and the Minister of Higher Education, Science and Innovation, Dr Igor Papič, colleagues from the Jožef Stefan Institute, Dr Romana Jordan, Iva Perhavec and Dr Kristina Žagar Soderžnik as well as distinguished guests at the Reactor Centre in Podgorica, spoke about progress in the field of gender equality. In the period of one year since the adoption of the first Gender Equality Plan for the JSI, the delegation presented the measures and progress in achieving gender equality, to which the Athena project, supported by the European Union's Horizon 2020 programme, made an important contribution, and informed them about the work of the Commission for Equal Opportunities in Science. Members of the delegation commended the Institute's efforts to promote equality and inclusion and recognised them as exemplary models for positive change. The discussion was followed by a presentation and visit to the Reactor Centre.

Minister Bojan Kumer at the Opening of the Renovated Nuclear Technology Information Centre

Podgorica, June 2023

Mag. Bojan Kumer, the Minister of the Environment, Climate and Energy visited the Nuclear Technology Training Centre (ICJT) in Podgorica. Mag. Bojan Kumer, Prof. Dr Boštjan Zalar, the Director of the Jožef Stefan Institute, and Dr Igor Jenčič, Head of the ICJT, opened the renovated Information Centre, the main purpose of which is to inform the public about nuclear technology. In the renovated space, where energy is presented as blue light on a dark background, the visitor feels like a particle traveling around the energy space.

The renovation of the Information Centre coincides with the 30th anniversary of the Centre, which has received exactly 200,452 visitors to date. With a renewed image, it is even more inviting for lectures as well as interactive and multimedia presentations on the topic of nuclear energy. »In Slovenia, events celebrating the renovation of real estate, especially in the field of research, are not common, so today I am all the more happy.«, emphasized the Director of the Jožef Stefan Institute, Prof. Dr Boštjan Zalar. »The fact is that technologies are becoming very specific, and if achievements within individual areas are not presented correctly, there may be misunderstanding and even resistance from the public. Here, the employees of the Information Centre as well as the employees of the Jožef Stefan Institute, in general, have an important task, because it is precisely with our clear presentations that we bring science closer to decision-makers and the general public.«

The Minister of the Environment, Climate and Energy, mag. Bojan Kumer, congratulated the employees of the Nuclear Technology Training Centre on their work. »We see your centre as one of the key pillars of ensuring the high level of qualifications for nuclear personnel, which Slovenia urgently needs. Nuclear energy is also of interest to the general public, and I agree that raising awareness of these topics is very important for understanding and making use of nuclear energy. And I believe that the renovated centre will contribute to an even more successful promotion of knowledge about nuclear technologies in Slovenia.«

The Head of the Centre, Dr Igor Jenčič, presented the Centre's origins and development. »The renovation of the Information Centre not only coincides with the 30th anniversary of the Centre, but we have also welcomed our 200,000th visitor and a total of 200,452 visitors to date. A survey of public opinion on nuclear energy shows that many of them are hesitant, in particular among young people, which makes our activity all the more important.«

The architects who led the renovation, Špela Nardoni Kovač and Igor Berlot, highlighted the basic issues. »One of these was how to show energy in a way that would be immediately understandable even visually. We chose the most ordinary display of energy, which is blue light on a dark background. Above all, we wanted to create a space where the visitor would have the experience of feeling like a particle traveling around the energy space. Experience seemed to us to be a very important upgrade of the data and knowledge that the exhibition itself offers. We also found it interesting to imagine the core of a hexagonal reactor and a fusion plasma pattern based on equilateral triangles. We spread out the network of equilateral triangles throughout the space and established billboards and exhibits along it, so that we got different spaces through which the visitor moves. The sequencing and diversity of the space allows visitors to focus on each topic, while at the same time be interested in what is around the corner and so has the motivation to explore what is to come.«


Reaktorji V. generacije
Generation V reactors
Reaktorji V. generacije bodo fuzijski reaktorji, v katerih se bodo jedra devterija in tritija ob visoki temperaturi zlivala v helij. Pri tem se bo sproščalo ogromno energije.
Generation V reactors will produce great amounts of energy by fusion of deuterium and tritium into helium.

Visits by Ambassadors

In 2023, the Jožef Stefan Institute was visited by ambassadors from India, Germany and Italy. The Indian Ambassador, Her Excellency Mrs. Namrata S. Kumar, representatives of the JSI and the Jožef Stefan International Postgraduate School were presented with work related to the LiFE initiative, which strives to place individual behaviour at the forefront of the global narrative on climate action. The participants agreed on a joint event in February 2024. The German Ambassador, His Excellency Mr Adrian Pollmann together with the Head of the Department for the Economy, Mrs. Eva-Ricarda Willems, and the Head of the Department for Culture and Media, Julio Neblich, visited the Department of Automation, Biocybernetics and Robotics, the Humar Lab and the Center for Electron Microscopy, after talks with the Institute's management. The Italian Ambassador, His Excellency Mr Carlo Campanile with the Director of the Institute, Prof. Dr Boštjan Zalar, examined the possibilities for even better cooperation between the two countries and visited some of the most interesting laboratories at the JSI.

Representatives of the CEA and the Ministry of Higher Education, Science and Innovation at the Reactor Infrastructure Centre

On 17 November 2023, representatives from the Science and Innovation Directorate, mag. Peter Volasko, the Division for International Cooperation and Popularization of Science, Ms Maja Krajnc, the Slovenian Research and Innovation Agency ARIS, Ms Tatjana Jurkovič and French guests from CEA Ms Julie Oddou, Executive Director for EU Affairs, and Mr Alexandre Barret from the EU Affairs Service visited the Reactor Infrastructure Centre. After the introductory greeting and presentation of the Institute, Prof. Dr Boštjan Zalar together with his colleagues Prof. Dr Luka Snoj and Prof. Dr Leon Cizelj presented the scientific research cooperation between the CEA and JSI, cooperation in the field of nuclear energy and the use of research reactors, and the French-Slovenian initiative for a new research reactor.

Science and Innovation, Slovenia and Italy

On 5 December 2023, the Science and Innovation, Slovenia and Italy event was held in Rome, and attended by representatives of the Jožef Stefan Institute. After the introductory speeches by the Minister of Higher Education, Science and Innovation, Dr Igor Papič, and the Director of the Jožef Stefan Institute, Prof. Dr Boštjan Zalar, the latter signed a list of five projects with CNR Director-General Giuseppe Colpani, which were selected in a call for proposals on the basis of the Cooperation Agreement between the Jožef Stefan Institute and the Italian Research Council CNR. Dr Darja Lisjak, Prof. Dr Nina Kostevšek, Prof. Dr Matjaž Žitnik and assist. Dr Kristina Žagar Soderžnik, together with their Italian partners, presented some of the research undertaken last year. Researchers from both institutes also listened to presentations of various companies and examined the possibilities for cooperation. In order to further improve ties between the two countries, Italian Minister Anna Maria Bernini and Slovenian Minister Igor Papič signed a memorandum of cooperation between the two countries in the field of science and innovation.

Director-General of the World Intellectual Property Organization, Daren Tang, at JSI

During his visit to Slovenia, the Director-General of the World Intellectual Property Organization, Daren Tang, also visited the Jožef Stefan Institute on 25 September 2023, where he met with the management of the institute, visited laboratories and participated in a round table on Intellectual Property and Commercialization. Together with the Director of the Slovenian Intellectual Property Office, Mrs Karin Žvokelj, he presented the national WIPO Awards. The WIPO Innovators Award went to Prof. Ddr Denis Đonlagić from the FERI of the University of Maribor, who works in the fields of laser diodes, optical fibres, sensors, systems and apparatus; his discoveries and innovations were granted eleven patents with substantive examination. The WIPO national award for companies went to Krka, d. d., Novo mesto, which is one of the leading generic pharmaceutical companies, and actively cooperates with domestic and foreign public research organizations as part of its corporate development. Dr Aleš Rotar, Member of the Management Board and Director of Pharmaceutical Development and Production, accepted the Award.

Michiel Scheffer, Chairman of the Board of Directors of the European Innovation Council, Visits JSI

In November, Michiel Scheffer, Chairman of the Management Board of the European Innovation Council, visited the Jožef Stefan Institute. The EIC has a budget of €10.1 billion under Horizon Europe. The funds are intended to support the best breakthrough innovation projects throughout their lifecycle, from early-stage research to proof-of-concept, technology transfer and the financing and scale-up of start-ups and small and medium-sized enterprises. Scheffer met with Prof. Dr Boštjan Zalar, the Director, and researchers of three EIC projects, Prof. Dr Peter Križan from the Department of Experimental Particle Physics for the EIC PetViSoin project, which is also coordinated by the institute, Dr Suraj Gupta from the Department for Advanced Materials for the EIC project Anemel and assistant Prof. Janez Zavašnik from the Gas Electronics Division for the EIC project ThermoDust. After presentations of the Institute and projects, a visit to the laboratories followed.

2. Innovation Day

On December 6, 2023, the Grand Hotel Union hosted the 2nd Innovation Day Ljubljana, organized by SRIP Factories of the Future together with the Jožef Stefan Institute and EIT Manufacturing. The event was a continuation of last year's event dedicated to robotics and manufacturing, but this time it focused on materials that play a very important role in the globalised world and are crucial to European industry. The focus was on presenting research and development achievements and designing and manufacturing modern functional materials, with an emphasis on permanent magnets based on rare earths, which are especially important for e-mobility, the space industry and clean energy. The participants were addressed by the director of the Jožef Stefan Institute, Prof. Dr Boštjan Zalar. Among other areas, the results of the EIT Manufacturing innovation project aProMag, coordinated by the Jožef Stefan Institute and Prof. Dr Spomenka Kobe, were presented. The entire event, which perfectly summarized the achievements of Slovenian science and industry, was led by the director of SRIP ToP Assist. Prof Dr Igor Kovač.

JSI Visited by the Chamber of Craft and Small Business

On 2 March 2023, the Jožef Stefan Institute and the Chamber of Craft and Small Business of Slovenia organised visits to the Institute for members of the Chamber. In the plenary session, welcome speeches by the host and guest representatives were followed by short thematic lectures on the possibilities of cooperation between the Institute and the small business and potential financial resources. This was followed by a visit to the laboratories, where we enabled our guests to register in advance for one to five programmes that covered four research departments each. In the last part, artisans/entrepreneurs and JSI researchers met for bilateral talks. The visit confirmed the great interest in cooperation between small businesses and the institute.

Meeting with Representatives of Pomurje on Upgrading Cooperation

On 16 February 2023, the management of the Jožef Stefan Institute met with the mayors of municipalities in Pomurje and members of the Presidency of the Pomurje Academy of Sciences and Arts – President Dr Mitja Slavinec and Secretary Dr Mitja Lainščak, also Director of the Agency for Research and Development of Slovenia, and Acting Director of the newly established public institute Scientific and Innovation Centre (ZIS) of Pomurje, Dr Petra Cajnko. The representatives of Pomurje proved to be most interested in upgrading the exploitation of geothermal sources, for modular reactors as possible sources of energy for the future and the possibility of establishing a food institute in Pomurje, as this would ensure energy independence on the basis of research on advanced energy sources, and also direct research to Pomurje's own activity – food production and analysis.

On 4 October 2023, a delegation from Pomurje visited the Reactor Infrastructure Centre of the Jožef Stefan Institute in Podgorica. They were received by Assistant Director for EU Affairs, Dr Romana Jordan, and colleagues to present various ways to monitor the authenticity and quality of food, the use of modern technologies in establishing a dynamic food-purchasing system, the possibility of using nuclear energy as a carbon-free energy source for the future, and the importance of scientific research work to ensure the safe operation of nuclear facilities. Guests took a closer look at the Triga and ICJT reactors and learned about the advantages that such scientific-educational facilities bring.

SCIENCE AND ART

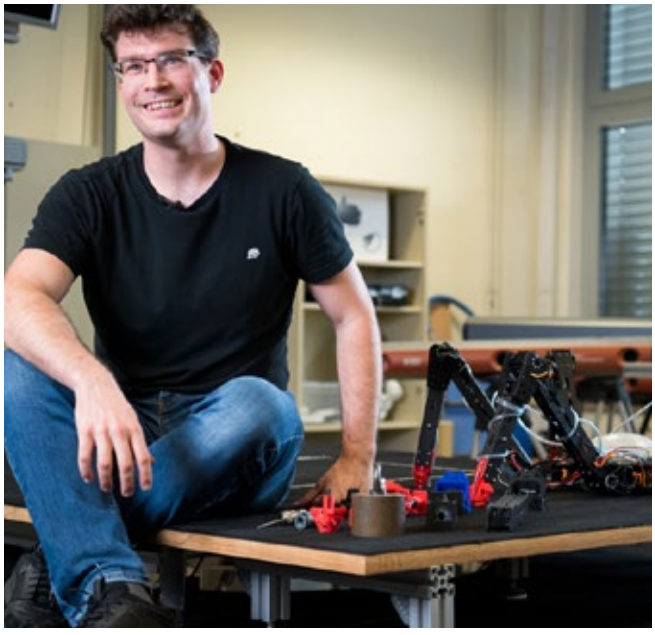
A special feature of the Jožef Stefan Institute is the direct interweaving of science and art, when one enters the space of the other, when they need each other so much that one does not exist without the other, and when they glow at the moment when one becomes two. It is then that science and art meet in their greatest differences, and at the same time in their greatest similarities. But they work together to offer the strongest feelings and experiences in terms of content and expression.
In a book entitled Science and Art, Different Sides of the Same Curiosity, published by the National Institute of Chemistry in December 2023, the former director of the Jožef Stefan Institute, Prof. Dr Jadran Lenarčič, presented his reflections on the relationship between science and art. »Slovenians are privileged, because we have our own science and our own art. Not everyone has this at such a high level.«

Marjan Smerke Exhibition

In November, the Family Gallery hosted an exhibition by Marjan Smerke a late collaborator of the Jožef Stefan Institute. After completing the first cycle of physics studies in 1960, Marjan Smerke started working at the Jožef Stefan Institute. He was employed until October 1997 and worked until his death in June 2017.
His photographic oeuvre is invaluable at our institute, as he recorded the most important events at the institute with his watchful photographic eye during this time and created a unique photographic archive. Marjan Smerke admired the sacral architecture and equipped the majority of the most beautiful monographs on pilgrimages and church art with photographs.
The exhibition was prepared by the National Museum of Contemporary History of Slovenia in cooperation with the Museum of Architecture and Design and the Office of Slovenian Photography at the Gorenjska Museum.

Plant-Watering Robot at the Exhibition konSekvence ≡ Fragments of a Possible Ecosystem

In March 2023, the exhibition konSekvence ≡ Fragments of a Possible Ecosystem took place at the Cukrarna Gallery in Ljubljana, where among the numerous exhibited works was StellaVerde - smart garden. At the centre of the work of authors Gregor Krpič and Simon Gmajner was placed a robotic spider, developed by colleagues Gal Sajko, Dr Marko Jamšek and Prof. Dr Jan Babič from the Laboratory of Neuromechanics and Biorobotics, which operates within the Department of Automation, Biocybernetics and Robotics at the Jožef Stefan Institute. StellaVerde is a micro-situation in which plants use moisture sensors to control the robotic spider to water them, and in the developed form it takes care of them and responsibly reaps their growth. The artistic study of the coexistence of humans, technology and living systems teaches us that humans as a society must reinvent ourselves and, through considerations of maintaining the balance in nature, formulate possible scenarios of non-extractionist coexistence.



The Jožef Stefan Institute Co-created an Application for the Online Collaboration of B-AIR Musicians

Ljubljana, January 2023

Applications for the online collaboration of musicians gained momentum in the period of the Covid-19 pandemic when choirs, bands and individuals replaced live music contact in rehearsals and recordings with an internet connection. Within the framework of the B-AIR project, led by Radio Slovenia, the idea of an AIR platform arose shortly before, in 2019. It would bring together sound and radio artists from around the world via the internet, while at the same time independently creating an alternative radio programme, the »endless« sound sculpture, from the sound material created in a collaboration.

Gregor Pirš, who designed the B-AIR project with Saša Rakef Perko, said: »This is an idea that came to me in 2018 at the meeting of the Ars Acustica Group as an alternative, infinite, virtually eternal radio station that eavesdrops on the world of various radiophonic events and stores all these impressions deep in the subconscious, ultimately forming itself from this memory in its own way and learning more and more, how to, according to what logic, combine different sounds.« In the open-source software environment Pure Data, Pirš, with the help of partners from the Jožef Stefan Institute, designed a platform, an online mixing desk that can combine all these channels, the sounds of artists from all over the world and record or convey them in their complexity.

On this birthday of art, January 17, 2023, a group of artists gathered to broadcast a project called The Kitchen live on an international exchange of radio stations led by the renowned British radiophonic artist and electronic music producer Matthew Herbert: »Herbert provided an aesthetically artistic conceptual framework, while we provided the technology. Together we met and produced 40 minutes of performance on the topic of the kitchen – it was about using everything a person could find in the kitchen, from cooking an egg to lids, knives, machines and so on. Austrian radio ORF played a leading role in this; they even held a cooking party and transmitted it in audio to our platform. Then a few more individual artists collaborated with their interventions. At times, the production worked very excitingly, of course, in what we like to call sound art, that is, the art of sounds, noise, known or undisclosed sources. It's an art that's not hard to listen to, it's not an avant-garde composition if someone makes music out of the sounds of a kitchen, but it's not music like you'd otherwise expect.«

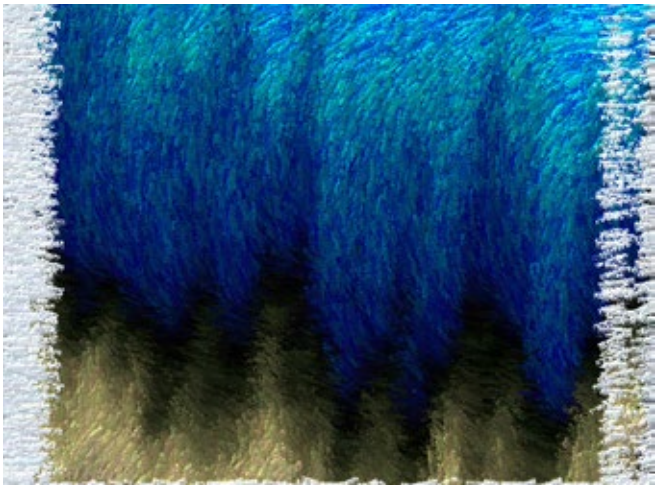
Performances from the kitchens were supervised by Hugh Jones, sound engineer and producer of Matthew Herbert at his Accidental Studio. He measured the practical test of the AIR platform primarily in the direction of connecting and opening a radio studio to the world: »If one tone master is in Canada, the other in Berlin and the third in Ljubljana, we at the Jožef Stefan Institute and on a very fast network, can unite this world somewhere into a meaningful whole,« concluded Gregor Pirš. Dr Jan Jona Javoršek, Head of the Network Infrastructure Centre at the Jožef Stefan Institute, added: »We were also lucky that the system components were flexible and connected to open protocols. Because our technical implementation was also a kind of kitchen, because at the last moment we had to adapt the systems already tested and completely new solutions to the artistic concept, which was changing until the last moment.«

JSI Employees at the Premiere of Guardians of the Formula

On 8 November 2023, at the invitation of the production company Perfo in Cankarjev dom, colleagues attended the inauguration ceremony of the Liffe Film Festival. The opening film Guardians of the Formula was also created with the help of the Jožef Stefan Institute, since the key scenes were filmed at our reactor. In his opening address, film director Dragan Bjelogrlić especially thanked the Jožef Stefan Institute and its excellent colleagues who dedicated themselves to helping the film crew with reactor filming and advised them about professional situations in the film. As in other countries, the premiere of the film Guardians of the Formula was given a standing ovation from an enthusiastic audience in Slovenia. In the photograph: friendly ties were forged between the film crew (director Dragan Bjelogrlić, actors Radivoje Bukvič, Jurij Drevenšek and Alexis Manenti) and the JSI, which were re-established at the premiere of the film.

JSI Goes to the Moon

The nanoart image of Janko Jelenc, an associate of the Department of Solid State Physics at the Jožef Stefan Institute, will be among 250 items from all over the world that will be sent to the Moon in a time capsule called MoonArk. The painting was selected in the framework of international online competitions organized by Christian Orfescu, which he also proposed for a selection for a project led by Carnegie Mellon University, USA.
Janko Jelenc is engaged in the synthesis and characterization of nanoparticles, or more precisely sensory microscopy, which involves very small particles that cannot be seen with conventional optical microscopes. The basis of the scanning sensor microscope is a very sharp tip or sensor with which certain surfaces are examined. »We move the sensor over the surface, then bring it closer to the surface, controlling the sensor via a feedback loop or electronics to follow the surface. In doing so, we look at the sensor offsets. And in this way, we obtain an image of the surface. That is, the sensor scans in rows, and when we fold all these rows together, we obtain the whole picture. The paintings are primarily intended for scientific presentations and are on a black and white scale, but in nano art painting the base is presented in a different, more attractive or abstract way. And every now and then, one goes to the Moon. Who will see it in 100,000 years?!«



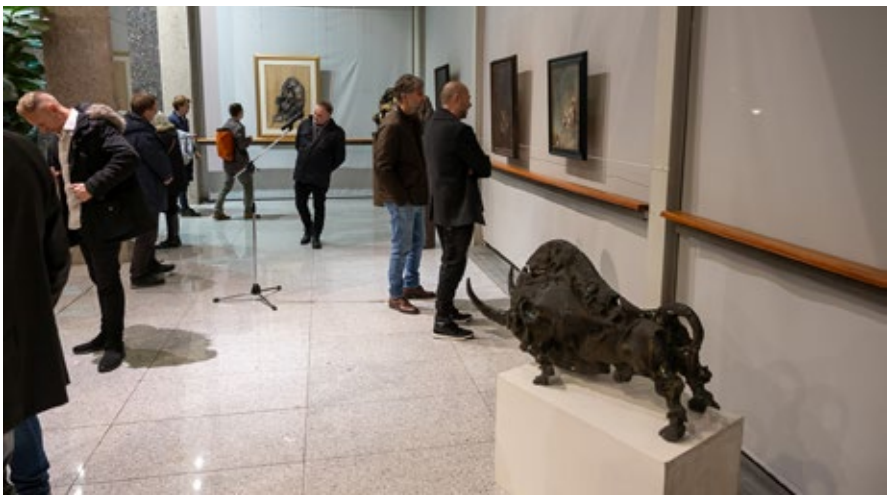
Gallery of the Jožef Stefan Institute

The gallery of the Jožef Stefan Institute has a long tradition. So far, 370 exhibitions have been organized, most of them independent. From its very beginnings, the designers of the programs strived for visitors to perceive in the scientific work the elements of visual beauty and the precision of science in art. The beginnings date back to 1980, when on November 12th, Milena Braniselj Kranjc and Jože Spacal exhibited their works. Under the guidance of Marjan Smerke at the Institute, Jože Spacal was also learning about laserograms and used them in his artwork. The JSI Youth Organization (1980-1990) was initially managing the exhibitions: under the mentorship of Dr Tomaž Brejc, professor of art history at the Academy of Fine Arts of the University of Ljubljana, active in this period were Radmila Milačič, Martin Lesjak, Zdravko Rupnik, Bano Dialo, Primož Mlakar, Boris Glavič, Marija Božnar, Antonija Lesar and Vera Dragić. After two years of non-operation of the gallery, Dr Viktor Dimic (1992–1995), assistant to the directors Dr Tomaž Kalin and Dr Danilo Zavrtanik, took over management of the gallery. Under his tutelage, the first to exhibit was Dr Jadran Lenarčič (September 25–October 12, 1992). His ambitious program was later implemented by Natalija Polenec, employed at the Institute as a public relations organizer, who also professionally designed today's layout of brochures/invitations to exhibitions (1995–2005). Physicist and painter Milan Rožmarin (2005–2015) then took over the continuation of the excellent program of exhibitions, and after his departure, chemist Petra Šutar has overseen the operation of the gallery together with the Gallery Council. During her maternity leave, she was replaced by mag. Marjan Verč (2020/2021), otherwise in charge of designing brochures/invitations and the photographic documentation of the exhibitions. The Gallery Council, which also has external members (art historians and art critics), prepares a high-level program every year consisting of eleven or twelve exhibitions. Exhibition openings, presented by various curators, are always well attended, and works of art are on display for employees and everyone who passes through the gallery every day. The content and poetics of the exhibited works enrich everyone. Especially if we know that art and science are connected by passion and the desire to explore, curiosity and the wonderful discovery of the new.

In 2023, the JSI Gallery exhibited:

Luka Širok	Impersonality
Drago Metljak	Mirror of life
Nande Vidmar	A selection of works from the collection of the Božidar Jakac Gallery, Kostanjevica na Krki
Silva Karim	Inner distances
Matjaž Stopar	Work in progress
Karmen Bajec	The bird desires freedom
Andrejka Čufer	Overview exhibition
Leonida Goropevšek	The curiosity of the imagination
Franc Golob	Pictures from the cycle Calling Spring (2009–2015)
Dominik Olmiah Križan	Images with poetry, utopias, and interpretations
Marjan Verč	The story of filming Guardians of the Formula
Janez Boljka	A selection of works from the legacy of the artist's studio


Ben gibt's nichts zu
liegt bereits
die ganze Welt
Ben gibt's nichts
du nicht weißt
du bist...
suchst...
in dir.



JSI FOR SOCIETY

Total of more than
20,600
visitors

Events	
Colloquia	1100
Gallery	9300
School visits	1100
Days of Jožef Stefan	650
Open Day	2000
Researchers' Night	350
Nuclear Technology Training Centre	6180

The mission of the Jožef Stefan Institute is to create, expand and transfer knowledge in the field of natural sciences, technical sciences and life sciences. Thus, one of the most important activities is the presentation of individual fields and workflows, the wide variety of equipment at the institute, as well as the presentation of the functioning and life of scientists. The Institute also participates in the preparation of expert opinions on current issues for the fields in which it operates.

JSI Colloquia

Within the framework of the JSI Colloquia, the Institute has always presented its research work with the best lecturers, which is why the JSI Colloquia are distinguished by their excellent reputation. Martin Klajnšek recollects: »When, more than two years ago, in October 2021, I took over the management of the Colloquia, I set myself benchmarks for preserving this reputation and maximizing the attendance at lectures. At the same time, new rules were adopted, according to which JSI employees who were recently elected to the highest scientific title, that is, to the title of Scientific Councillor, should present their research work at the Colloquia. This type of lecturer probably represents an ideal combination with age-increasing experience, and maintained youthful enthusiasm, which in principle promises excellent lectures.«

Dr Martin Klanjšek summarised the organisation of the Colloquia in 2023 by saying: »In 2023, with the help of professional associate Nataša Goševac, graphic designer Lenka Trdina, public relations representative Polona Strnad, and technical associates Tomaž Krištofelc and Igor Djilas, I organized 18 lectures. Four of these lectures were by recently elected scientific councillors and all lived up the reputation of the Colloquia. So I look forward to future lectures of this kind. Some of the other lectures were particularly relevant to the spirit of the times. Of these, I would like to highlight the very first lecture in 2023, in which Asst. Prof. Dr Igor Lengar of the JSI presented the situation in the evolving field of fusion energy. I organized the lecture on the occasion of the recent announcement by American scientists that they had succeeded for the first time in triggering a nuclear reaction that generated more energy than it consumed. In the early autumn, world-renowned expert in this field, Prof. Dr Thomas G. Dietterich

You are invited to watch recordings of the lectures at kolokviji.ijs.si:

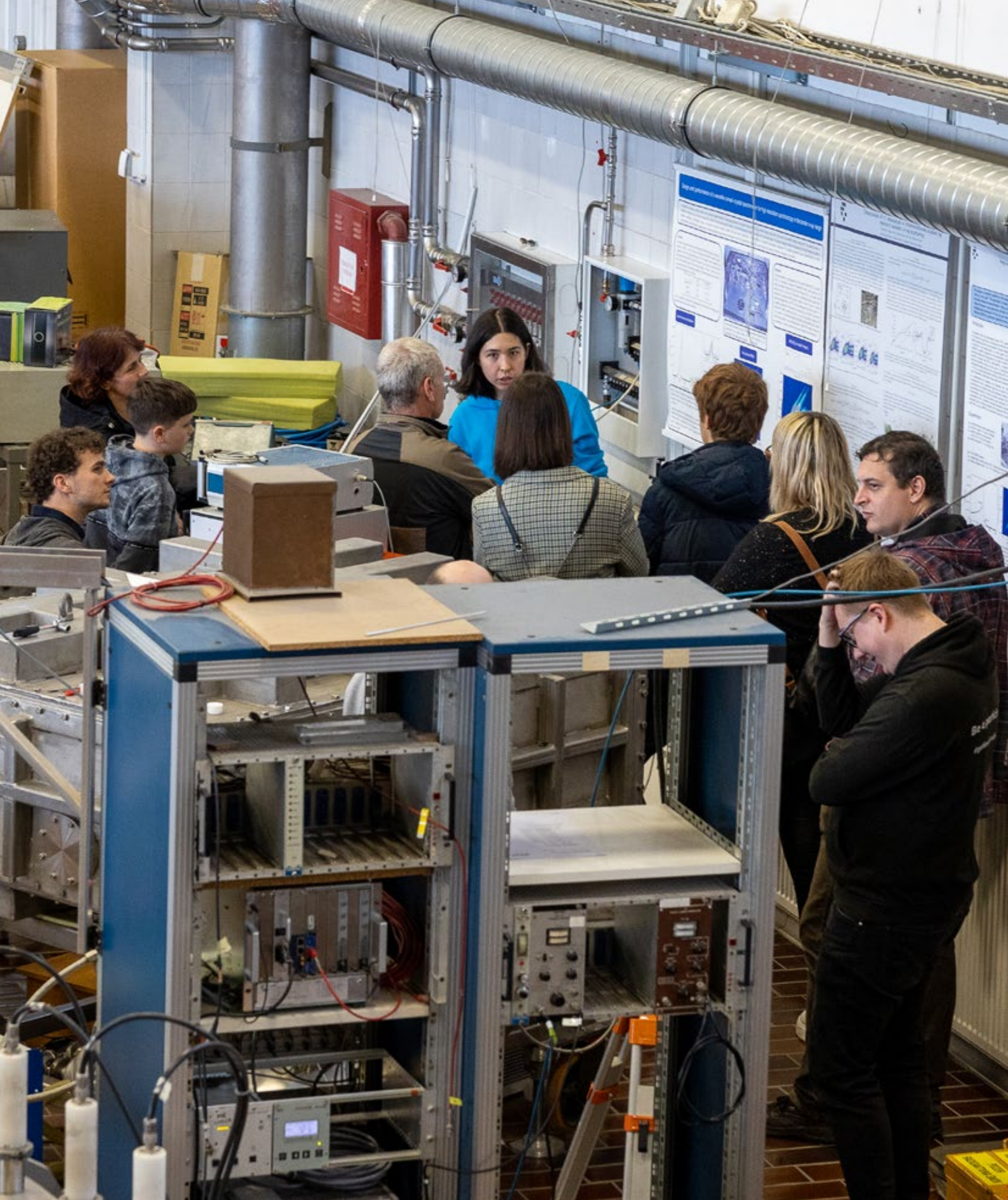
6 December	**Lev Vidmar**	Physics at the edge of chaos
29 November	**Svjetlana Fajfer**	On the way from B meson anomalies to new physics
22 November	**Boris Majaron**	Development of photothermal radiometry techniques for use in biomedicine
18 October	**Andrew J. Bell**	Take it to the limit: a story of piezoelectric materials and devices for extreme conditions
27 September	**Igor Mandić**	Solid state detectors for future colliders
20 September	**Qiwen Zhan**	Dreams about dreams: topology with spatiotemporally sculptured light
29 June	**Thomas G. Dietterich**	What's wrong with large language models and what we should be building instead
21 June	**Eduard Llobet Valero**	Gas sensors based on transition metal dichalgogenides
14 June	**Lev Ioffe**	What can we learn from noisy quantum computers right now?
10 May	**Philippe Bouyer**	Quantum sensors with matter waves
5 April	**Miha Čekada**	Hard protective coatings: between science and industry
23 March	**Nada Lavrač and Marko Robnik-Šikonja**	Machine learning from relational and textual data
22 March	**Ester Heath**	Pollutants of concern: the journey from sources to the environment
21 March	**Lukáš Palatinus**	Select Crystallography in the 21st century: the age of electron?
20 March	**Frédéric Mila**	Quantum spin liquids and their experimental realizations
1 February	**Igor Serša**	Magnetic resonance microscopy
25 January	**Vladimir Vava Gligorov**	Coherent test of lepton universality in beauty to strange quark transitions
11 January	**Igor Lengar**	Harnessing fusion energy and recent successful experiments

from Oregon State University in the USA, gave a lecture about the large language models that had a major impact in 2023. I must also highlight all four lectures within the framework of the Jožef Stefan Days, which covered almost all the scientific fields of our Institute and were all extremely well attended.

In order to ensure that the announcements of the Colloquia have the greatest possible reach and attract as many visitors as possible, we have redesigned the entire graphical identity of electronic invitations and posters, and at the same time renewed the Colloquia website – judging by the responses quite successfully. I would like to conclude by saying that the Colloquia maintained their reputation in 2023, but were also very well attended, certainly significantly better than the year before, when the effects of the global Covid-19 pandemic were still lingering.«

Jožef Stefan Days

The Jožef Stefan Days are held in memory of the famous Slovenian physicist Jožef Stefan, born on March 24th, 1835. The aim of the event is to popularise science. From March 20 to 25, 2023, the 31st Jožef Stefan Days were held, with Saturday being the traditional Open Door Day.



JSI's Open Day

In honour of the memory of the famous Slovenian physicist Jožef Stefan, after whom our Institute is named, the 31st Days of Jožef Stefan took place in the week between 20 and 25 March 2023. On a rainy Saturday, we had more than a thousand visitors at an individual location, mostly families, schoolchildren, pensioners and also many foreigners. They were able to visit the laboratories and get to know more closely the work of researchers in Ljubljana (at Jamova and Teslova) and at the Reactor Centre in Podgorica near Ljubljana.

School Visits

The Institute is happy to welcome an organized visit by a school group, as we are aware of the importance of encouraging young people in the areas of science and technology. During the school year, we usually accept one school per week, when pupils or students can view the work in three research departments per visit. In 2023, we organized 41 such visits, when 38 schools or over 1100 schoolchildren visited us. To thank them for the excellent cooperation, we also organised a picnic for visit coordinators at the end of the school year 2022/2023. On a sunny Monday, 22 May 2023, in the afternoon, about 40 visit coordinators from »Jamova« and »Reactor« gathered at the Reactor Centre in Podgorica, as well as some employees of the U7, U8, U9, ZIC and U1, including the director of JSI.

Researchers' Night

This year, as part of the European Researchers' Night, we opened the doors of the Institute to the public on 29 September 2023. The open-door evening, which took place at both locations, was very well attended. Visitors of all generations were impressed by interesting experiments, workshops, tours and exhibitions. Polls pointed out that the event was »education for all generations«, »we learned a lot of new things about science« and »we had fun.«

As part of the workshops, visitors were able to find answers to the question of how to see elementary particles, learn what a vacuum is and how plasma is formed, and become acquainted with superconductors. They also looked for answers to questions about what kind of food and where it came from to reach our plates, and experimented in the School of Experimental Chemistry.

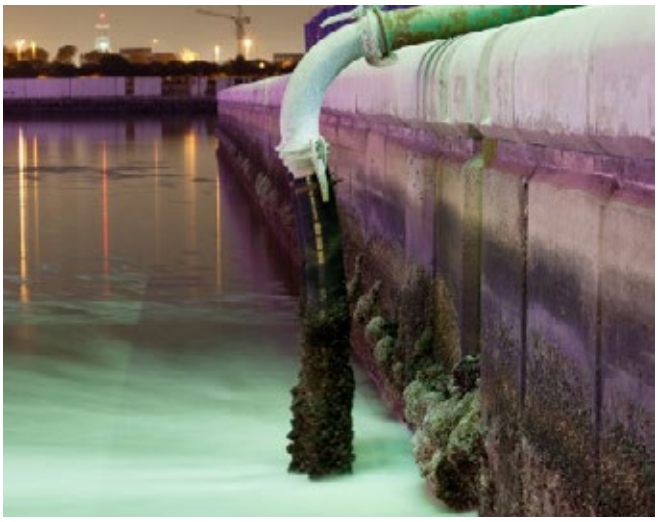
They learned how to protect metals with innovative coatings and peek into the eyes of worlds invisible under microscopes, including electronic ones. The Office for Project Informatics, Organization of Thematic Events and Conferences, was also presented at the event. We enriched the events on Jamova with two performances entitled Flash, heat and cold – chemistry shows its true face and enjoyed a musical accompaniment. The Reactor Center presented the TRIGA nuclear reactor to visitors. They visited a renewed interactive exhibition on energy and nuclear technology and could also play with LEGO microbial cubes.

International Day of Women and Girls in Science

11 February marks the International Day of Women and Girls in Science. In 2023, it focused on the role of women and girls in addressing global challenges to achieve the Sustainable Development Goals (SDGs). The success in tackling the challenges of the 2030 Agenda for Sustainable Development depends on our ability and willingness to unleash the enormous untapped potential, knowledge and talents of women and girls around the world, who remain insufficiently involved in scientific research, especially in the natural and technical fields. On this occasion, the Jožef Stefan Institute, in cooperation with the US Embassy in Slovenia, organized a lecture by Dr Aubrey R. Paris, The role of women in the development of solutions to climate change.

Department of Environmental Sciences in the International Illicit Drug Survey SCORE 2022

The European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) has published the results of an international survey on illicit drug use, SCORE 2022. In total, 118 cities with catchment areas of 132 treatment plants participated in the monitoring, and 41 laboratories were involved in the analyses, including the laboratory of the Organic Analysis Group of the Department of Environmental Sciences at the Jožef Stefan Institute under the leadership of Prof. Dr Ester Heath. Among Slovenian cities, the highest mass load is recorded on the majority of target drug residues (benzoylecgonin – biomarker of cocaine, MDMA – biomarker of ecstasy and methamphetamine) in Ljubljana, and amphetamine in Velenje, as in previous years. The highest mass load of THC-COOH (biomarker of THC) was recorded in Koper, closely followed by Ljubljana. Given the average mass load of biomarkers of illicit drugs, none of the Slovenian cities ranked among the top 20 participating cities in 2022. Out of the 15 cities that reported ketamine content for the first time this year, Ljubljana ranked fifth.



Jožef Stefan Institute at the Science Rally

On 21 September, employees in higher education and research gathered at Novi trg in Ljubljana for a science rally for the fair remuneration of research assistants. The rally aimed to highlight the unenviable salary position of employees in various professional positions.

Professional services are crucial in carrying out teaching and research work, both at universities and at research institutes, which is why the management of universities and institutes strives and supports efforts to ensure the decent remuneration of research assistants, and above all equal opportunities and equal pay for similar jobs within the public sector, as workers in similar jobs are paid very differently within different segments of the public sector.

The demands of the rally were also supported by colleagues at the Jožef Stefan Institute, and a personal experience was presented by Boštjan Črnič, a technical associate at the Department of Low and Medium Energy Physics. »In our department we are a mix of researchers, about one third to one half, while the rest are technical associates and technicians. Our work, although it sounds very different, is very intertwined. Apart from writing articles, which is mostly limited to researchers, everyone else does the same work: for example, when we walk into the field and sample and process soil, rainwater, groundwater, where we are confronted with natural phenomena such as storms, rain, snow, mosquitoes and the like, or we go abroad for experiments, sometimes on our own, without researchers, as professional associates and technicians, and we transport equipment across borders, which can be quite a challenge. We do all this with the awareness that we are doing something important for the common good, that together as a group we achieve better results, with which we can apply for projects, create new ideas, and last but not least, ideas for the development of new products appear, on the basis of which even new companies can be created. All this work is intertwined and consists of technical associates and researchers. We do this work because it makes us happy. The salary, of course, is a motivation, and we would have liked the salaries to be adjusted to today's costs, but nevertheless, if I had not had the pleasure of doing this job, I would not have done it. We are aware that there are not so many of us in Slovenia, and if we do not do this work, who will? To all decision-makers who have any opportunity to change anything, remember: if you do not take care of us, Slovenia will be left without knowledge. We want to work together to encourage each other to achieve our results, to achieve the best position possible, the appropriate position that belongs to us in society. In order to work together, knowledge in Slovenia will continue to be disseminated and enriched. And to prevent that knowledge in Slovenia starts getting lost. Thank you to everyone who has come. I believe we will make a difference for the better.«

Energy Efficiency Centre in the SharePlanica Project

Although Slovenia is perceived as a green country, statistics on CO_2 emissions in the field of transport show a different picture. Taking into account the number of inhabitants, Slovenia is the third largest emitter in the EU in terms of transport, with nine percent above the EU average. Great sporting spectacles, such as the Ski Jumping World Cup final in Planica, increase the burden. Here, more than 50% of CO_2 emissions can be attributed to transport. Therefore, Mastercard and Planica have set themselves an important goal: to reduce the number of cars in Planica by 2023. They created a car-sharing platform shareplanica.si where visitors to Planica announced their journey or joined advertised rides. Just think how much CO_2 we can avoid with a single shared ride to Planica. This data was provided by the Energy Efficiency Centre of the Jožef Stefan Institute, which took care of real numbers during the project. Yes, a single journey from Ljubljana to Planica and back is responsible for the same amount of CO_2 emissions as a 7-W LED that is switched on for a year and a half.

The shareplanica.si platform recorded more than 150 journeys to Planica and more than 300 ride seekers. It contributed to a reduction of 12 tonnes of CO_2. The SharePlanica project was one of the finalists of the Effie Slovenia 2023 competition. Marko Kovač from the Centre for Energy Efficiency said about the cooperation: »It was an operation that is a little out of our usual framework, but it seemed to us that we would gain insight into a different way of thinking. And indeed, we got a very nice insight into how positively different people think about sustainable mobility. Such a combination of sociability (attending an event) and energy efficiency has also given us incentives to make the green transition feasible, which is definitely positive news, at least for us who are working with the Integrated National Energy and Climate Plan. Thanks to the Agency101 for a great deal of patience with scattered scientific minds.«

JSI's Employees Helped Flood Sufferers

After Slovenia was hit by violent flash floods on the night between 4 and 5 August 2023, which developed after storms with extremely heavy rain, and floods were followed by avalanches due to the wetting of the terrain, the whole of Slovenia, along with the Jožef Stefan Institute, immediately organised itself and offered assistance to the most affected areas and people. The Institute immediately sought direct forms of assistance, from solidarity assistance, rapid money-collection campaigns, assistance from trade unions, cooperation with Civil Protection and volunteer firefighters, direct assistance to the most affected young people and the search for further effective solutions.

Immediately after this natural disaster, we enabled our colleagues actually affected by flooding to receive solidarity aid, and we organised a rapid fundraising campaign in which we collected €9000 and allocated them to the most urgent necessities for eliminating the consequences in one of the Savinja Valley collection centres. On Saturday, 12 August 2023, ELME researchers (Ecological Laboratory with a Mobile Unit), which operates within the Civil Protection of the Republic of Slovenia, carried out sampling in the Mežica valley, and analyses of samples were carried out in laboratories of the Department of Environmental Sciences. From day one, some colleagues participated as members of the Civil Protection Service in organizing and coordinating assistance in various municipalities around Slovenia.

ELME Introduces Itself

In September, the Ecological Laboratory with a Mobile Unit (ELME) at the Jožef Stefan Institute organized a professional and social event for representatives of the administrative bodies with which our laboratory cooperates. As part of the event, they presented the role and functioning of ELME in the Slovenian protection-and-rescue system and demonstrated their current capacities to respond to accidents with dangerous substances at home and abroad. They touched on the challenges posed by the new chemical, biological, radiological and nuclear (CBRN) threat currently facing the EU and outlined their plans and ideas for future work and development. In this way, they wish to further strengthen their cooperation in the Slovenian and international protection-and-rescue forces.

JSI Partner of the KRPAN Project

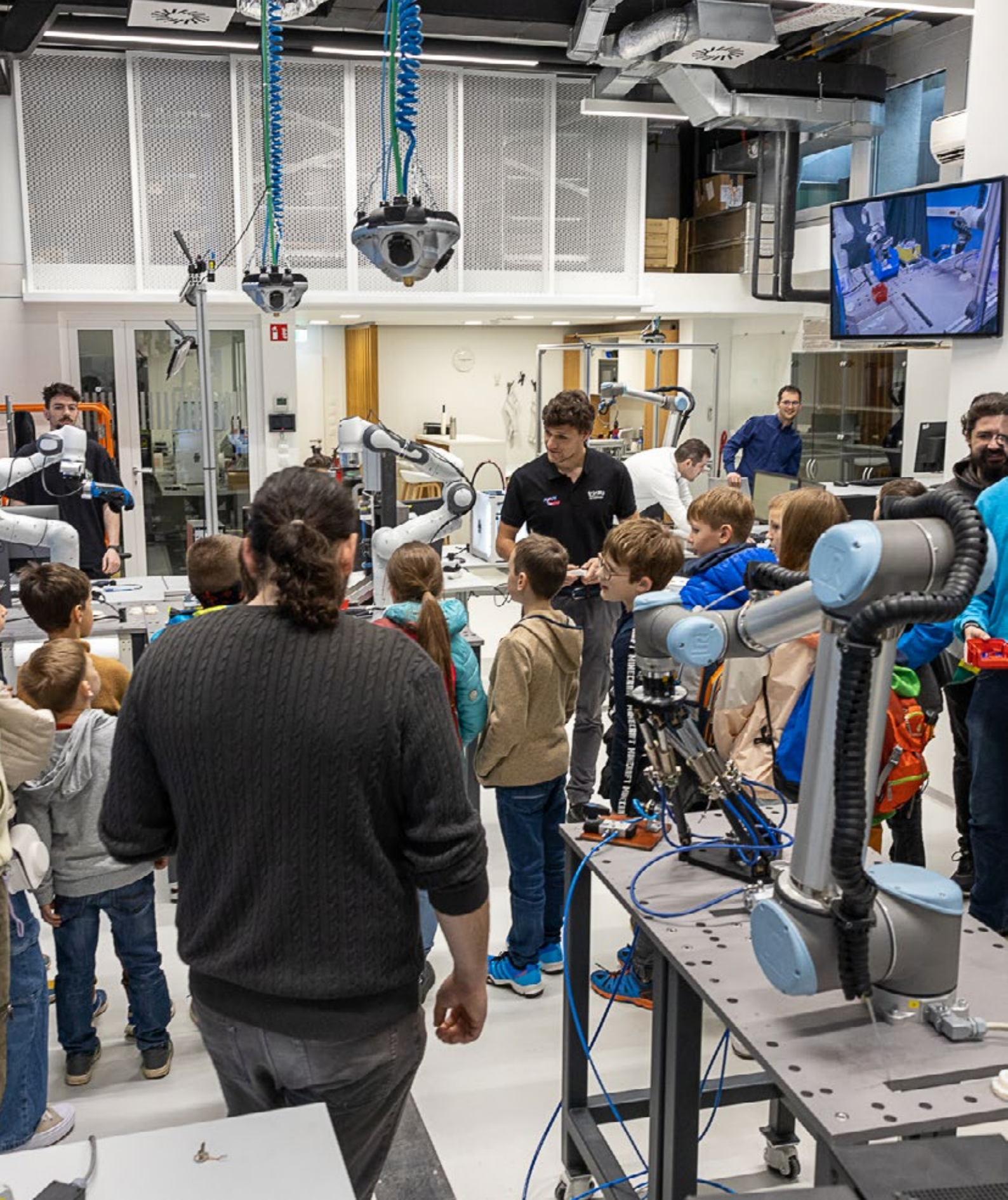
The European Union and the EU Member States are increasingly aware of the importance of professional support for researchers when it comes to their success in applying for research projects as part of centralised European calls and in implementing and managing European research projects. The KRPAN project consortium started with the implementation of the project Strengthening Research Support and Activities for Progress on European Research Projects, which is co-financed by the Ministry of Higher Education, Science and Innovation and the European Union within the Recovery and Resilience Facility. The purpose of the project is to strengthen research support and increase human resources in the project offices of partners, improve knowledge and competences for writing applications for competitive tenders of European centralized programmes, and find additional opportunities for interdisciplinary and cross-sectoral networking of researchers in partner organisations. The partners of the project consortium are: the University of Ljubljana as the project coordinator, the Jožef Stefan Institute, the University of Maribor, the University of Primorska and the Scientific Research Centre Koper.

EUREM Training Completed for Groups of Students

On 24 February and 15 December 2023, EUREM trainings were held and were completed by groups 14. and 15. The certificates were awarded by the Minister of the Environment, Spatial Planning and Energy, mag. Bojan Kumer, and the Director of the Jožef Stefan Institute Prof. Dr Boštjan Zalar. EUREM - European Energy Manager - is a certified qualification, it was started in Germany in 1997 and has been successfully implemented in Slovenia since 2008 at the Centre for Energy Efficiency. EUREM education is focused on acquiring knowledge for the implementation of energy-efficiency measures and includes the theoretical part (lectures and the group solving of tasks), a written exam and the preparation and defence of the project task. We are proud of the contribution of EUREM education to faster achievement of energy and climate goals, as Slovenia is the leading country in terms of the number of EUREM energy managers per population, and is also the leader in the number of awards received. As part of the annual conferences of European energy managers, Slovenian energy managers have already received 16 awards. This year's training was successfully completed by 20 European energy managers. In their project tasks, they processed 20 projects for the more efficient use of energy and the use of renewable energy sources. The total energy saving potential is almost 4 GWh/year, the potential to reduce emissions of 2 kt CO_2/year, reduce costs more than €5 million/year, and investment costs of €2.1 million with a minimum payback period of 0.4 years. In 15 editions, 289 candidates have successfully completed the certified EUREM educational programme, and the 16th course starts in March 2024.

Students in the Planica Laboratory

Prof. Dr Igor Mekjavić, an associate of the Department of Automation, Biocybernetics and Robotics at the Jožef Stefan Institute, achieved new success with the Laboratory of Space Physiology in Planica. He placed Slovenia alongside France (Caen University in Normandy) and Germany (Charite University of Berlin) with an educational programme. Next year, the 6-year SpaceMed Erasmus Mundus Joint Master project will be launched in these three countries, while along with Planica part of the programme will also take place in Slovenian caves and in the highlands of Bovec. Every year, the contractors plan the attendance of around 20 students from different countries, and Slovenian companies from the field of space technologies also participate in the project. »In the Planica laboratory of the Jožef Stefan Institute, students will learn about the effects of weightlessness and explore how artificial gravity could prevent the negative effects of weightlessness on humans,« said Prof. Dr Mekjavić. »Now we also have a lot of extreme conditions on Earth, one of which is global warming, there will be more and more heat waves, so in this programme we will also explore this issue.«



Open Day of Networking Infrastructure Centre

The Jožef Stefan Institute once again co-organised the traditional Open Day of Supercomputer Centres across Slovenia in October. Under the leadership of Dr Jan Jona Javoršek, Head of the Networking Infrastructure Centre, organized groups and individuals were able to visit the JSI Supercomputer Centre in Teslova, where, in addition to the JSI's systems, HPC Arnes, the second-largest supercomputer in Slovenia, is hosted. The company Arctur in Nova Gorica, the Ažman Center at the National Institute of Chemistry in Ljubljana and HPC Vega at the University of Maribor also opened their doors to visitors. The biggest attraction was certainly the possibility of visiting HPC Vega, a Slovenian supercomputer at IZUM in Maribor, which is a joint project of the Slovenian National Initiative for Network Supercomputing and the first computer of the European EuroHPC initiative.

Vega Supercomputer

The Vega supercomputer, with which IZUM put Slovenia in 21st place in the world rankings of countries equipped with supercomputers, also achieved records in 2023. In cooperation with the administrators of the JSI, the system of the European initiative EuroHPC was once again best utilized and achieved record data transfers.

Update of the Integrated Energy and Climate Plan of the Republic of Slovenia

the Integrated National Energy and Climate Plan is an action strategic document for the energy climate policy of the Republic of Slovenia, and in accordance with the Regulation on the Governance of the Energy Union, all EU Member States must update it by June 2024. The Energy Efficiency Centre of the JSI is led by a consortium of ten professional institutions that is preparing an update of the document, especially in the light of new, more demanding EU targets for 2030, due to the aggravated climate and energy crisis and achieving Slovenia's climate neutrality by 2050 at the latest. Increasing energy and material efficiency, phasing out fossil-fuel resources, increasing the use of renewable energy sources, nuclear energy and other low-carbon energy sources, while ensuring a reliable and competitive energy supply and adhering to the principles of climate justice are the main challenges we face in the preparation of new scenarios, goals and measures for the successful achievement of the set goals in Slovenia. However, stimulating research and innovation and investing more in training and awareness-raising are key factors for the necessary deployment of new technologies and services for a successful green technological transition.

JSI is a Partner in the SMASH Project

The Jožef Stefan Institute, together with the University of Nova Gorica (UNG), the University of Ljubljana (UL), the Agency of the Republic of Slovenia for the Environment (ARSO) and the Institute of Informatics (IZUM), is one of the partners of the COFUND project SMASH worth €10 million, which is co-financed by the research and development programme Horizon Europe. In the next 5 years, its goal is to attract 50 excellent postdoctoral researchers from all over the world, including Slovenian researchers and researchers abroad, who will use machine-learning methods, artificial intelligence and the Vega supercomputer to conduct research in various fields of natural sciences and humanities. Mobility opportunities and training at the highest level in scientific and transferable skills will be additional priorities of the SMASH project, facilitated by the programme's exciting group of associate partners in Slovenia, the EU and beyond. SMASH is the first COFUND project coordinated by a Slovenian organization. SMASH is also looking for postdoctoral researchers in 2024 who will propose ambitious projects to advance the subject area of their choice combined with the power of the Vega high-performance computer. More information is available at https://smash.ung.si/.

SMASH

JSI in the SPOZNAJ Project

The Jožef Stefan Institute, together with 20 Slovenian public research organizations, will be one of the partners of the project Support for the Implementation of Open Science Principles in Slovenia (SPOZNAJ), within the framework of which they will adjust their operations in accordance with the Act on Scientific Research and Innovation Activities, the Implementation Regulation scientific research work in accordance with the principles of open science and the practices and principles of open science in the European Research Area. Open science includes open access to research results, evaluation of the quality and impact of scientific research work using responsible metrics, and the involvement of citizens in scientific research work. The project, which will run until June 30th, 2026, is co-financed by the Ministry of Higher Education, Science and Innovation and the European Union - NextGenerationEU through the National Recovery and Resilience Plan. The purpose of the project is to raise awareness, educate and empower the associates of the consortium partners with relevant knowledge and competences in the field of open science, prepare educational material, establish support structures and adapt the mechanisms of operation of the consortium partners in accordance with the principles of open science. The SPOZNAJ project is part of the wider European development of open science. Indeed, the EU defined open science as one of the key measures of the Research and Innovation Pact in the period 2022-2024 and also legislated it with the revised Directive (EU) 2019/1024 of the European Parliament and of the Council of 20th June 2019 on open data and the reuse of public-sector information.

Strategic Days

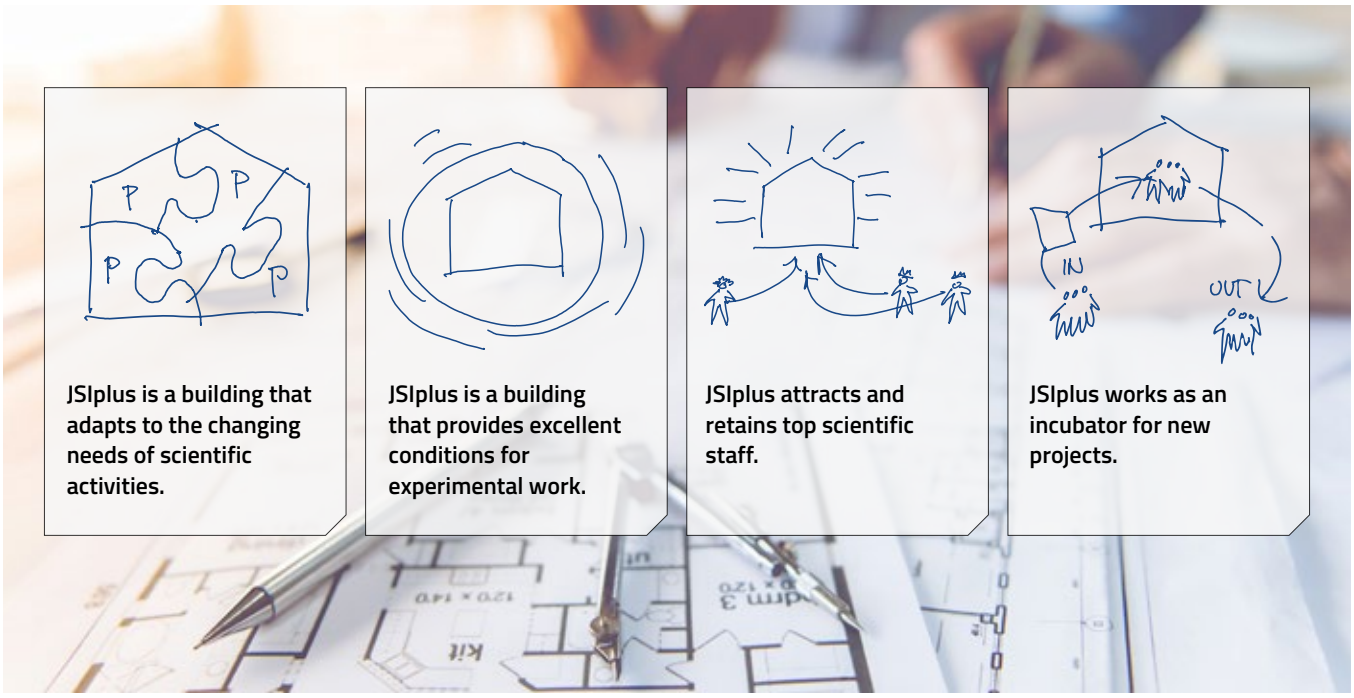
On November 7th and 8th, 2023, the Strategic Days, the purpose of which was to present current issues, achievements and plans for the Jožef Stefan Institute, were held in Portorož. The two-day meeting was attended by leaders and some representatives of the departments, and the main topics were spatial issues at the Institute, innovations in joint services, activities of the expert councils, Open Science and the business affairs of the Institute. The Institute's image and the need for new premises were highlighted as important priorities, to which the Institute will devote even more attention in the coming years. Interesting presentations provided an insight into the current situation, and the constructive discussion, including informal ones, offered many new considerations and solutions.

JSIplus

Basic science co-shapes the future and contributes to increasing productivity and innovation. On a practical level, progress is manifested in new products and high-tech solutions that allow industry to offer new jobs with added value. Research activity is key to solving problems related to climate change, ecology and the need for energy. The Jožef Stefan Institute contributes to the realization of the vision of a green future with scientific excellence. With innovations and breakthrough technologies, the Jožef Stefan Institute supports the national economy and raises Slovenia's international competitiveness. The initiative to build a modern research centre for light, matter and quanta, called JSIplus, stems from decades of internationally recognized research at the Jožef Stefan Institute in the field of quantum physics and chemistry, smart materials and advanced computing. With JSIplus, the stability of the environment will be ensured for the long term, in which domestic and foreign researchers in the field of natural sciences and technology will demonstrate their scientific excellence. This is crucial for a breakthrough in solving challenges in the field of natural science and technology, such as applications of quantum phenomena and artificial intelligence methods in biochemistry, medicine, electronics, energy and sustainable development. In accordance with the principle of sustainable development planning, the JSIplus project will make a major contribution to achieving national strategic goals.

At the Jožef Stefan Institute we are dealing with a serious shortage of space for our research work. That's why the construction of a new research center JSIplus is of key strategic importance, both for the development of the Institute and for the development of the country and Slovenian society. JSIplus will:

- further strengthen cooperation between research organizations and industry, including small and medium-sized companies,
- attract scientific talents to Slovenia from all over the world, and young researchers on new career paths,
- encourage research training and lifelong learning in all key areas, including new skills for the future.



JSIplus is a building that adapts to the changing needs of scientific activities.

JSIplus is a building that provides excellent conditions for experimental work.

JSIplus attracts and retains top scientific staff.

JSIplus works as an incubator for new projects.

ČasopIJS
The Jožef Stefan Institute in 2023
ISSN 2820-5790

Publisher:	Jožef Stefan Institute
Editorial board:	Polona Strnad (editor) Tomaž Krištofelc (technical editor) Marjeta Trobec Marjan Verč Polona Umek Igor Djilas Duško Odić
Design:	Lenka Trdina
Photos:	Marjan Verč, Luka Virag, Sarah Poženel, Tomaž Velechovsky, Mare Bačnar, Boštjan Podlogar, Adobe Stock and the JSI archive
Translation and proofreader:	Paul McGuiness
Printing:	Tiskarna Grafos, d. o. o.
Place and year of publication:	Ljubljana, 2024
Circulation:	500 copies
Price:	free

casopijs@ijs.si
www.ijs.si

Education

Total
244
faculty members lecturing at ->

55
supplementary staff

189
regular staff working with higher-education institutions

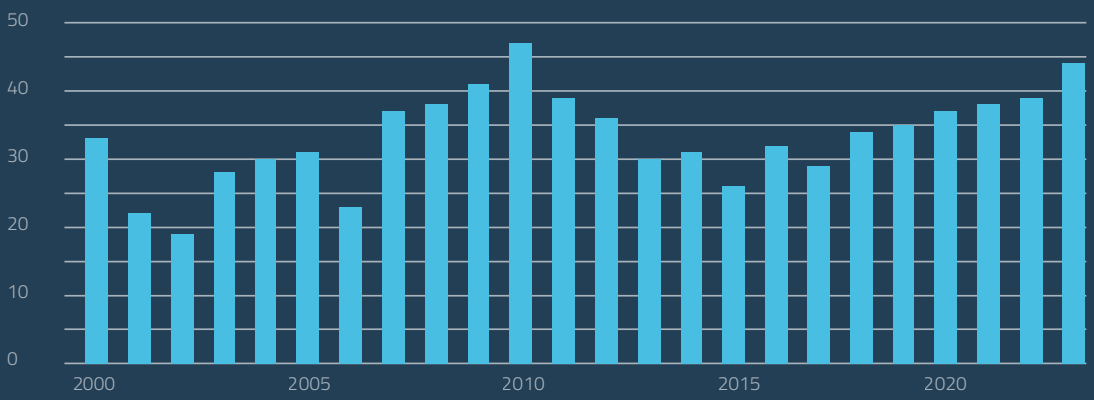
total
49
higher-education institutions

35
number of Slovenian higher-education institutions involved

14
number of foreign higher-education institutions involved

Young researchers

Total
799
young researchers covered by ARRS funding in the period 2000–2023 by year



Projects

Total
770
projects

333
projects financed by the national agency: **ARIS**

147
projects financed by different **European Union schemes**

158
market projects: domestic

132
market projects: international

Appearances in the media

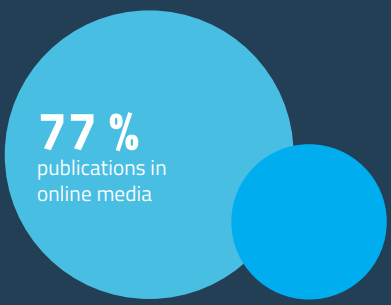
Total
2,811
media releases

Media that wrote the most on these topics:

1. novice.najdi.si
2. sta.si
3. Delo
4. rtvslo.si
5. delo.si

Authors who wrote the most on these topics:

1. STA
2. Saša Senica
3. Borut Hočevar
4. Sabina Petrov
5. M.K.



The institute in numbers

900+
published articles**

42,477
citations*

9
ERC projects

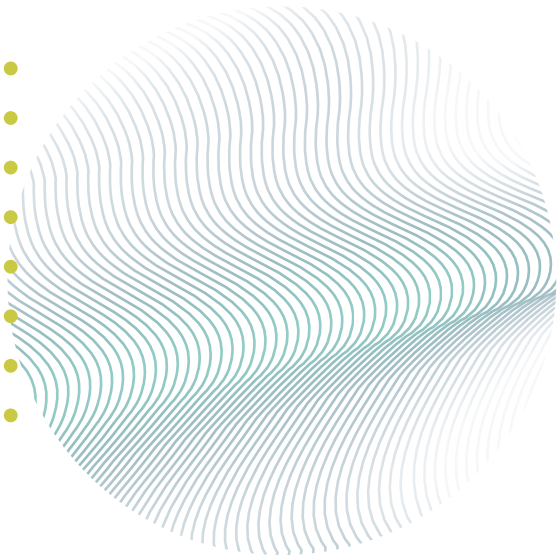
770
projects**

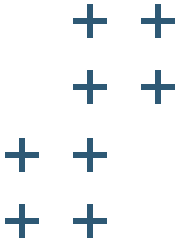
122
awards***

2,811
media releases**

20,600+
visitors**

*Data collected on 31.12.2023
**Data are for 2023
***Data for 2000-2023





Jožef Stefan
Institute
Ljubljana, Slovenia