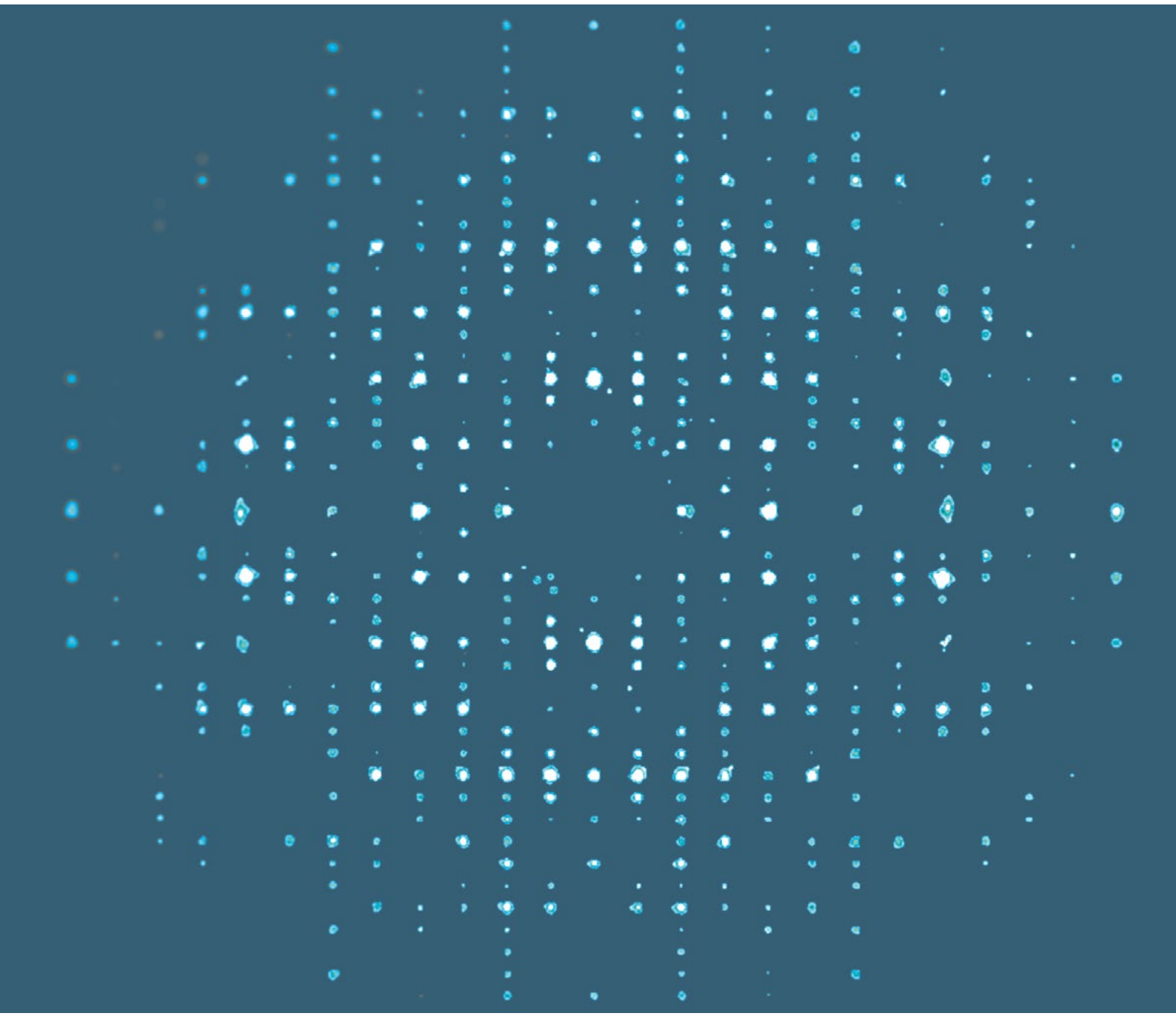
ANNUAL REPORT 2020



arrs
SLOVENIAN RESEARCH AGENCY

Introductory words

The year 2020 was in many ways different from what we were used to in the past, and this has been true for the Agency as well. The time during which I took office will certainly be influenced by the change in leadership, but more importantly, it will be marked as the most turbulent period in the Agency's existence, with particular emphasis on the great importance of science to society, and the surge in innovation and technology in research findings. The coronavirus pandemic has shaped our daily lives for the past year, it has deprived many people of their normal lives and caused many to lose their lives, but has also led to giant leaps in certain scientific fields. For instance, the end of 2020 has brought us in record time the first Covid vaccines, some of which employ technologies that have never before been used in medical practice.

During this time, the Agency has adapted its way of working to the new situation. The former well-established methods of conducting evaluation procedures have been reshaped to suit the new situation, enabling the reviewers to work remotely. Similarly, most of the Agency's internal processes have been redesigned. Instead of the originally planned calls for proposals and calls for research and infrastructure programmes, the Agency conducted a thematic call to increase funding for research programmes dedicated to the COVID-19 pandemic. Moreover, the Agency conducted an additional call for targeted research programmes dedicated to the COVID -19 pandemic, and calls with the SNSF and FWF as lead agencies were dedicated to this topic, as well. Despite the difficult situation, the Agency expanded international cooperation and concluded an agreement with eleven European agencies on multilateral co-financing of research projects based on the principle of a lead agency.

In implementing the call to increase funding for research programmes, the Agency took a different approach than usual, replacing the reviewers with an evaluation panel to carry out the evaluation procedure. The new approach was guided by the evaluation procedures the Agency had become familiar with in recent years in its international activities within the Norface consortium and the JPI Urban Europe.

In the past, the Agency had started activities to prepare a strategy for communication with professional and lay public and for promoting proposals of Slovenian researchers to European and other international calls. According to our perception, the Agency's operation is once again at an important turning point, which is why the responsibility for its operation is even greater. The working environment must provide employees with a predictable foundation for work, supported by reliable and modern information technology, and a workload appropriate to the workplace. The work performed by the Agency's staff is necessary for reliable funding of a large part of scientific activities in the Republic of Slovenia, and consequently an appropriate staff structure is required not only in terms of reliability, transparency and efficiency, but also to ensure the fulfilment and well-being of the staff.

Although the Agency has successfully adapted to the mode of operation needed in the new conditions brought on in 2020, the new situation has ruthlessly exposed weaknesses in its operations that stretch years into the past and have been pointed out by my predecessors who had made efforts to resolve them.

Allow me, therefore, to take a slightly more personal view as I begin my term. The central shortcoming of the Agency is that many important processes depend largely on a single person because of the continuing shortage of staff. While it is true that the Agency was exempted from the limitation on new employment imposed by the Aggregate Human Resource Plan for Public Law Entities at the end of 2020, this was much like a Pyrrhic victory as additional recruitment was severely restricted by implementation of the Republic of Slovenia Budget for 2021 and 2002 Act. Due to the insufficient number of qualified staff, the past year has been extremely stressful for the Agency. With the staff currently available, the Agency is unable to cope with the continuous improvement of procedures, the introduction of pilot instruments, the increase in international activity and, with particular emphasis, the management of information processing risks. The exemption of the Agency from the Aggregate Human Resource Plan for Public Law Entities has brought on the prospect of changes that were anticipated to facilitate operations while not yet fully resolving the challenges that have arisen over the last decade and that have been caused by the inability to formulate a sustainable human resources policy.

The activities during the pandemic have also shown the importance of strengthening interdisciplinary approaches, promoting inter-institutional collaboration, promoting scientific achievement, the scientific occupation and, of course, the success of scientists, and the importance of science to society and its development. As early as the spring wave of the epidemic, a national survey on the prevalence of COVID-19 in Slovenia was conceived in the form of an interdisciplinary survey of national importance. The results of the national survey contributed to a better understanding of COVID-19 characteristics and their prevalence in the population, thus contributing to a more effective management of the pandemic.

Over the years, the Agency has been actively involved in the preparation of new legislation as well as the governance of research activities. We have closely monitored the steps related to harmonisation and adoption of the Scientific Research and Innovation Activities Act, which we tried to co-create with our proposals to the best of our ability and to the greatest extent possible. The Agency is committed to securing stable financing as rapidly as possible, and endeavours to facilitate the transition from the current system to a new, simplified and efficient one. This surely pertains to the Act, but moreover includes the finalisation of applicable regulations, their timely adoption, and the recruitment of the staff needed to carry out the tasks stipulated by the new laws and regulations.

Prof. Dr. Robert Repnik
Managing Director

Annual report 2020

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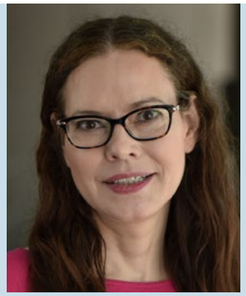
Cover:
X-ray diffraction pattern of a xenon compound crystal.

Content

Management board

The Management Board directs and monitors the activities of the agency. It consists of seven members, nominated by the government for a period of five years. In its current position, the management Board has been operating since 2019. The term of current members ends in 2024.



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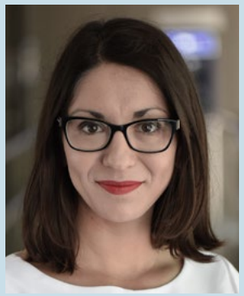
CERIC-ERIC

Prof. dr. Egon Pelikan
vice president
Institute for Historical Studies, Science and research centre Koper

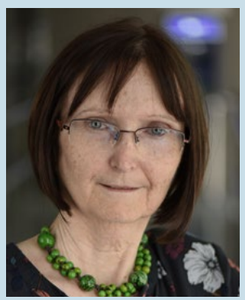


Dr. Emilija Stojmenova Duh
University of Ljubljana, Faculty of Electrical Engineering

Dr. Tonček Kregar
Museum of Recent History Celje

Dr. Justina Erčulj
National School of Leadership in Education (retired)

Prof dr. Janez Bonča
University of Ljubljana, Faculty of Mathemathics and Physics



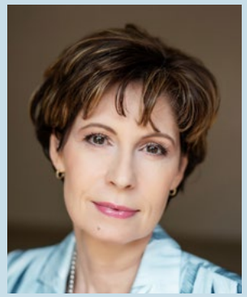
Prof. dr. Marta Klanjšek Gunde
National Institute of Chemistry

Scientific Council

The Scientific Council is the Agency's highest professional and advisory body. It consists of six members, covering all the research studies within the Agency's classification. The term of current members ends in 2025.

Prof. Dr. Peter Križan
president
natural sciences and mathematics
University of Ljubljana
Faculty of Mathematics and Physics

Prof. Dr. Željko Knez
engineering
University of Maribor
Faculty of Chemistry and Chemical Engineering



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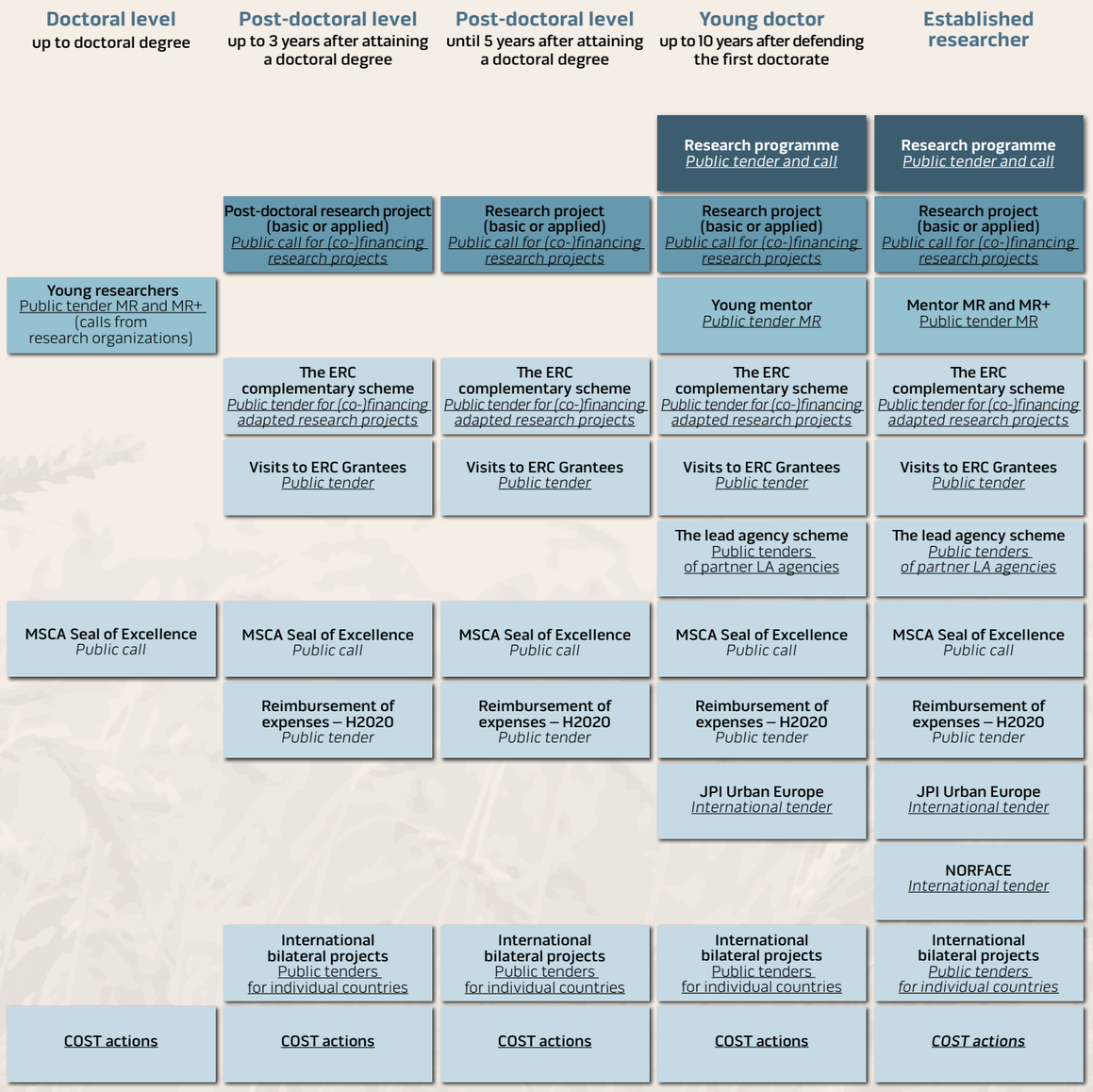
University Medical Centre Ljubljana

Prof. Dr. Janko Kos
biotechnical sciences
University of Ljubljana
Faculty of Pharmacy

Prof. Dr. Miha Škerlavaj
social sciences
University of Ljubljana
School of Economics and Business

Prof. Dr. Alenka Zupančič Žerdin
humanities
Research Centre of the Slovenian Academy of Sciences and Arts

ARRS funding mechanisms



Information on other available mechanisms available at: **http://www.arrs.gov.si/sl/razpisi/**

IN THE SPOTLIGHT

The work of a scientist is never or only very rarely in the public eye, whereas the demands and expectations of scientific work are often uncompromising. We have been able to realise this in the last year with the urgency for a vaccine to stop the spread of the COVID-19 pandemic. But only rarely are we aware of the many years or decades of hard scientific work behind such results. Assistant Professor Dr. Matic Lozinšek eloquently and with with great subtlety summarised such aspects of the cognitive process: "Scientists live in a swift-flowing stream of ideas and we absolutely need to look up over the fence and beyond the boundaries of our narrow research fields. A broader view expands our horizon and enables the discovery of a breakthrough idea." It was such a breakthrough idea that won Dr. Lozinšek a European Research Council Starting Grant despite strong competitors.

"Scientists live in a swift-flowing stream of ideas"

Assist. Prof. Matic Lozinšek
"Jožef Stefan" Institute (JSI)

winner of ERC funding

Dr. Matic Lozinšek, with a delay of a few months due to the COVID-19 pandemic, we would like to present you as the winner of the ERC Starting Grant, which ensures funding to researchers starting an independent research path. The title of your winning research is Challenging the Oxidation-State Limitations of the Periodic Table via High-Pressure Fluorine Chemistry. Can you please explain to us what your research is about?

The main idea of this research project is to combine two quite challenging, or we may even call them exotic, research fields. One is fluorine chemistry. Fluorine is an element with the symbol F, located in the upper part of the periodic table, right at the top of the group called halogen elements. This is an extremely reactive element. We may argue that it is the most reactive non-metallic element of the periodic table. The goal of this project is to investigate how this element reacts under extremely high pressures. We are talking about pressures somewhere between 10,000 and over 100,000 bar, which we create in cells with diamond anvils. You may find the construction and size of such a cell a bit surprising. When thinking about extremely high pressures, we usually imagine massive devices weighing a few tons, while these cells with diamond anvils are actually quite simple little devices, at the heart of which is the superhardness of a diamond.

You have been awarded the greatly coveted research project funding from the ERC (European Research Council). What was the deciding factor that convinced the thorough scrutiny of the evaluation committee?

I think it was the ambition and originality of this project. The project builds on my past research experience in fluorine chemistry, but at the same time introduces a whole new breakthrough direction of research, i.e. fluoride chemistry under extreme conditions. As mentioned earlier, we are combining two quite complex research areas.

The allocated amount is 2.4 million Euro for a period of five years. Out of 3248 applicants, you were selected as part of a group of 436 projects. This is a great success for you personally and for the Jožef Stefan Institute, as well as for Slovenian science in general.

At the ERC's PE4 panel for Physical and Analytical Chemistry, where I applied with the project, only 16 out of 120 project proposals were selected for funding. My project was one of those 16. Moreover, this is the first project in Slovenia to be granted additional funding above the established amount of 1.5 million Euro, in this case for the purchase of modern research equipment.

The projects approved by the European Research Council are generally basic research projects. Nevertheless, researchers do express the desire or notion that their research achievements may benefit the wider scientific community in some way, or even lead to a change in the scientific paradigm. Do you share similar thoughts?

Of course. The breakthrough scientific discoveries that the European Research Council seeks to promote with its funding, certainly have a broader scientific impact that extends beyond the narrow disciplines into which modern science is fragmented.

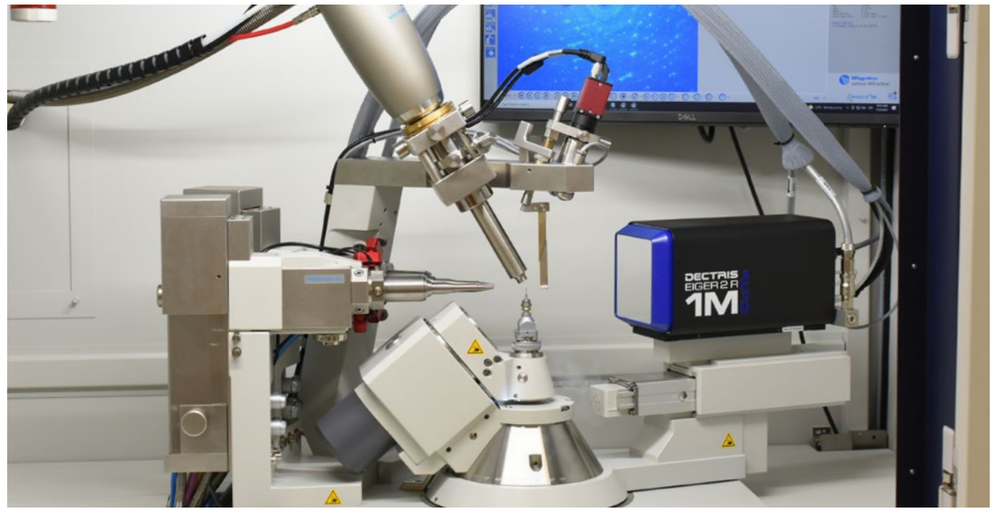
As mentioned earlier, you are researching fluorine. Why this element, what makes it so exciting? Could you tell us more about it?

Fluorine is the lightest representative of the halogens, which is a highly reactive family of elements in the penultimate column on the right side of the periodic table. In this family of elements, fluorine is at the extreme in terms of reactivity and reacts with all other elements of the periodic table, with the exception of the lightest noble gases. Much can be learned about the chemistry of these elements from the reactions of fluorine with other elements. And that is the objective of our project. Using fluorine and high pressures, we will study the chemical reactivity of other elements in the periodic table. To summarise, fluorine and high pressures will be a kind of experimental tool in this research.

Your research is complex and sophisticated, and requires special research equipment. So it is all the more noteworthy that you have obtained special funds to buy a modern X-ray diffractometer. Can you tell us something about this?

The X-ray diffractometer allows us to study the atomic and molecular composition of matter. It functions on the principle of X-ray scattering in a crystalline sample, as the wavelength of X-ray light is similar to the distances between atoms in matter. This modern, high-performance diffractometer that we have now, is essentially adapted for high-pressure studies. Earlier, I mentioned a cell with diamond anvils. In addition to the fact that diamond is the hardest substance, it is also important that diamond is transparent for a large part of the electromagnetic spectrum. In this cell, the substance will be under high pressure, and we will send X-ray light using the X-ray diffractometer to the sample through one side, and analyse the X-ray light coming from the cell through the other diamond anvil. This process will enable us to track how the substance reorganises itself, what reactions have taken place, and what the structure of the substance is under such exceptional pressures. I am very happy that the ERC have approved the project, and granted additional funding to purchase this really excellent instrument. I can hardly wait to start using it.

In addition to getting the research equipment, you will also form a research group. Are there any conditions regarding the number, status, seniority or scientific orientation of your researchers? Are only Sloveni-



Monocrystalline X-ray diffractometer adapted for measuring crystal structures under high pressure purchased within the HiPeR-F ERC project.

an researchers allowed to join the group or can you also invite people from abroad?
Let me answer this way: The European Research Council puts the person who proposed the research project at the forefront. And the person to whom the project has been assigned has a completely free hand in assembling the research team. At the same time, we need to keep in mind the research problem, we need to attract people who have certain knowledge that we do not have. I envisioned my research team to consist of two or three doctoral students and a few postdoctoral fellows. In any case, we will co-operate with researchers who are more experienced in our field of research, but the decision is entirely up to the project leader. The team is not limited to Slovenian members and I hope that some people from abroad will join us.

What are your research project obligations? Do you ultimately need to deliver any applicable results? I'm rephrasing my earlier question...
This depends on the project. This specific project is basic research through and through. We are interested in how we can discover any additional chemical reactivity of the elements. In the first phase, we will not deal much with the application aspects. Nevertheless, each new discovery also entails some possible usefulness or applicability. My opinion is that all basic research is applicable, and that it is only a matter of time to find its applicability. Even with the discovery of electricity, no one could have foreseen that it will completely change our lives. Similarly, we can say that if some part of the territory has not been discovered, we have no way of knowing whether there are natural resources to be found there or not. First, we need to explore the territory, and then we can talk about usefulness or applicability.

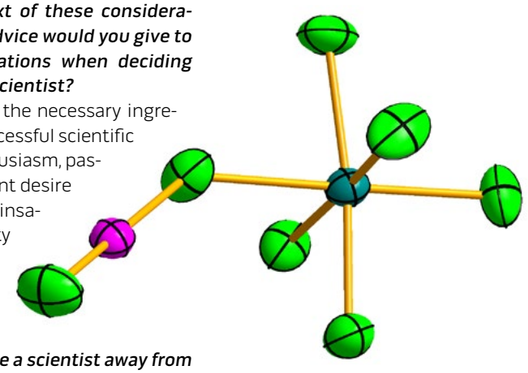
What attracted your research interests to start working with fluorine?
I was attracted to this field because of the complexity of the experiments and because experimental work is generally interesting in and of itself. I first encountered fluorine chemistry as a student at the Faculty of Chemistry and Chemical Technology, University of Ljubljana, during my work experience internship at the Jožef Stefan Institute under the mentorship of Prof. Dr. Boris Žemva. I became so absorbed in this chemistry that I went on to complete my undergraduate and doctoral studies under his mentorship. I did my postdoctoral work in Canada in this field. The ERC project is also in the field of fluorine chemistry, so this element is still accompanying me on my path.

With the extensive body of knowledge that researches have about a particular problem, they are looking for "something more" in solving certain issues, be it basic understanding or applied solutions. Can you describe your cognitive process, how does an idea emerge? What is the role of teamwork, attending international conferences, discussions with researchers from other environments, and similar?
Everything you have listed I find extremely important and surely contributes to new ideas. All of these activities drive the research work. For me, it is very important to read literature as it gives me a lot. I mean literature in a broader sense, not only pertaining to the narrow discipline that the researcher is currently researching. This is also reflected in attending various conferences and summer schools, where researchers are exposed to a swift flow of scientific ideas. This is an opportunity to learn about progress in other fields and about discoveries that have been unknown to you. This is what allows you to find the kind of breakthrough idea that is needed for an ERC project. I learned about research under extreme conditions and research under high pressures, especially using X-ray crystallography, at summer schools and conferences on X-ray crystallography. This is how the idea slowly emerged that it would be extremely interesting to combine these two areas. To me, it is of utmost importance for researchers to be exposed to a swift-flowing stream of ideas, that we look up over the fence and beyond the boundaries of our research fields.

How do you perceive science today? The pace of development in all fields is extremely fast, a lot is expected from science (at least in the last year this was very obvious). Scientific disciplines are increasingly more intertwined, and competition is becoming ruthless. Can such a situation act as an incentive or is it more like an inhibitor of ideas and achievements?
I think there is more than one answer to this question. Due to the rapid pace of development and scientific progress, it is certainly exciting to work in this field and to be part of it. At the same time, insufficient funding, outdated infrastructure and disorderly conditions severely hamper the activity.

Which scientific disciplines do you think have the greatest impact on the development of humankind today? We can hear that this is the century of biotechnology, artificial intelligence, special branches of medicine, even chemistry...?
I believe that it is precisely the intertwining of various, sometimes narrowly specialised disciplines, that drives progress. Findings in a certain field enable progress in a sometimes quite distant field. It seems that quantum technologies will be at the forefront in the future. Chemistry also plays a role in this area, as it provides the substances and materials in which quantum phenomena manifest. Also very important are the research and technologies which will enable us to avert the depletion of the natural environment caused by the human overpopulation of planet Earth and our materially and energetically wasteful lifestyles.

In the context of these considerations, what advice would you give to future generations when deciding to work as a scientist?
I believe that the necessary ingredients for successful scientific work are enthusiasm, passion, a constant desire to learn, an insatiable curiosity and a pinch of creativity.



What can drive a scientist away from strenuous and long-term research? We know this is hard work.
I would like to point out inadequate working conditions, an unstimulating scientific system and administrative overload. These are the factors that kill scientific creativity. Unfortunately, many young talents do not even get suitable opportunities to pursue their scientific interests. There is no adequate scientific career development, as there are systemic shortcomings and poor funding opportunities in this area.

Do you perhaps find that scientific work is ascribed enough importance nowadays? What I have in mind is the syntagm pronounced by various decision-makers and opinion leaders during the past year: "Science has saved us in the COVID-19 pandemic".
The latter is undeniably true. However, the answer to the other part, whether science is perceived as important, I would say is no. Slovenia has no natural resources. But we do have bright people. We will only become a knowledge society if we support knowledge extensively. Education transfers knowledge, and scientific research creates new knowledge. Unfortunately, these fields are not a priority to our decision-makers, despite the fact that investing in research and development has the greatest multiplier effect in the long run. However, it is true that research and innovation are like long-distance running, and decision-makers in our country seem to be able to run only short distances.

The entire interview, prepared by *Ina Petric* is available at: www.tromba.si

ARRS Day 2020: Supporting Excellence

In line with the 2016–2020 ARRS operation and development strategy, the vision of the Agency's operation and development is set within the framework of seven strategic guidelines, including Open communication with the public and promotion of science. In public communication, the basic goal of the operation is to contribute to more qualified reporting and public debate on science and the scientific system in the Republic of Slovenia.
In December 2020, the Agency for the third time organised the "ARRS Day 2020: Supporting Excellence" which was substantively dedicated to addressing current topics related to the COVID-19 pandemic. Due to the pandemic situation in 2020 the event was carried out as a podcast.
The introductory part of the event addressed the basic issues of the operation and vision of the Slovenian Research Agency and its role in the development of Slovenian science while the central panel part of the event focused on current topics of the COVID-19 pandemic.

As part of the ARRS Day 2020: Supporting Excellence, a formal reception of the new generation of young researchers was held, also in a virtual form as a ceremonial address.
Dr. Simona Kustec, Slovenian Minister of Education, Science and Sport, was the keynote speaker.

The event took place under the auspices of Borut Pahor, President of the Republic of Slovenia.

After that, the ARRS **Excellent in Science 2020** promotion project was carried out for the ninth time. Within the project the most prominent research achievements of the year in all scientific disciplines were presented. In the selection of Excellent in Science 2020 achievements there were 21 projects. Their presentations were available for viewing after the live broadcast on the event website had completed.

Science Communication Days 2020

Science Communication Days were held in January 2020 as the second set of promotional activities under the auspices of the Science Communication project. The current concept of the event including a renowned foreign guest has been preserved. Science Communication Days derive from the Science Communication project (Kom Zn) within which the Agency has been organising professional workshops since 2014. It is a three-day set of events dedicated to raising awareness of the importance of science communication and acquiring skills in the field with a world-famous expert as a central guest and other accompanying events.
In order to promote quality media reporting on science, we want to empower media representatives as well as researchers, improve communication and increase the presence of science in the media by planning a three-day set of events and activities. Through the acquisition of knowledge and skills specific to writing reports on science gained through the Science Communication project, we want to increase the credibility and authenticity of scientific reporting in Slovenia.

The special guest of the Science Communication Days 2020 was Fabio Turone, the scientific journalist and founder of the Centre for Ethics in Science and Journalism and president of the professional association Science Writers in Italy. (Photo: STA)

The following events were organised as part of the 2020 Science Communication Days:

- **Workshop for researchers with Anja Hlača Ferjančič, journalist of Radio Slovenia - Val 202** on the topic of media skills.

As part of a set of three events, visitors were able to attend a practical workshop for researchers. Anja Hlača Ferjančič conducted a workshop on strengthening quality and credible reporting. In a few exercises she showed us how to strengthen our capacity by improving our media skills.

- **Interview with Fabio Turone**, scientific journalist and founder of the Centre for Ethics in Science and Journalism, intended for representatives of the Slovenian scientific research community (university rectors, directors of public research institutes and other representatives of research organisations). The interview with the principal guest was led by Ksenija Horvat, journalist and host of the Intervju show, RTV Slovenia.

In a conversation with science journalist Ksenija Horvat, Turone said that science sometimes does not have the right answer to journalists' questions. "Because science is based on evidence, it is sometimes necessary to say that there is no answer, especially when speaking of health-related topics," he pointed out.

On the sidelines of the event, the president of ARRS management board Jana Kolar stressed that science communication is more important today than ever before. According to her, we are facing many challenges today - it is science which can provide the answers and these have to be addressed in an understandable way.

The three-day set of events ended with two workshops:

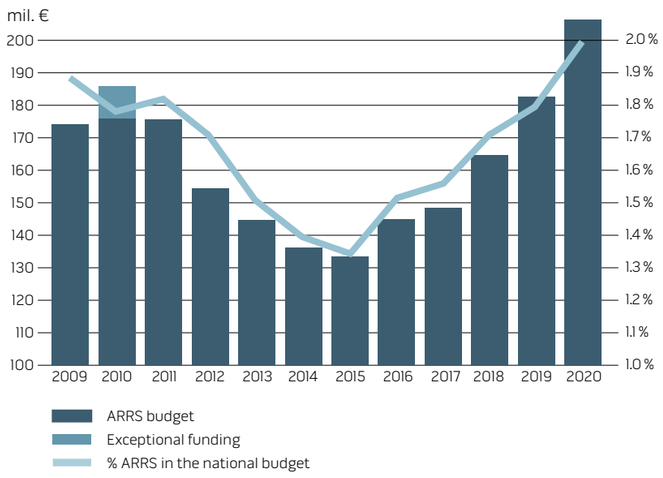
- **Workshop for editors and journalists with Fabio Turone** on the topic of scientific writing, media coverage of science and specific journalism skills.
- **Workshop for researchers with Fabio Turone** on science communication and creating social dialogue on the relevance of science and its results.

FINANCIAL REPORT

FINANCING STRUCTURE

In 2020, the budget of the Republic of Slovenia, through the Slovenian Research Agency (hereinafter: the Agency), provided EUR 206.7 million for the financing of scientific research, which is EUR 24 million or 13 % more than the year before.
The Agency's budget for scientific research activities increased from EUR 175.9 million in 2011 to EUR 206.8 million in 2020, representing a difference of 13.2 %. The first increase of funds after 2011 was recorded in 2016, and was 8.6 % greater than the year before.
In 2016, 1.5 % of the budget of the Republic of Slovenia was dedicated to the Agency for scientific research, in 2020 that share was 2.0 %.

Agency funds for scientific research activities and their corresponding share of the budget of the Republic of Slovenia



A detailed overview of the financing of research activities is available on the following website: http://www.arrs.si/sl/finan/letpor/. More data and charts on the scope and structure of financing received by the Agency from the national budget are available on the following website: http://www.arrs.si/sl/analize/obseg01/pr.asp.

Image on previous page:
Vacuum system for fluorine chemistry research at the "Jožef Stefan" Institute.

Agency funds in 2020

Research programmes: long term financing of research, which is expected to be current and applicable over a longer period of time.

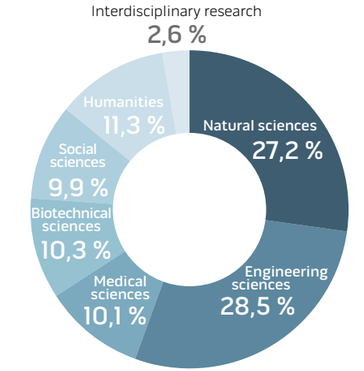
Research projects: co-financing of basic, applied and postdoctoral research projects, targeted research programmes and those of young Doctors of science in the pilot public call framework "Employment support of young Doctors of science".

Junior researchers: financing of postgraduate studies and training of researchers aiming to obtain a doctorate.

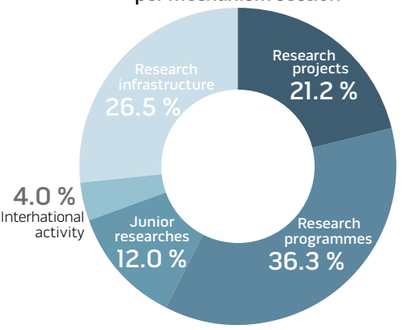
International activities: co-financing of projects within the complementary schemes of the ERC and the schemes of lead agencies, visits to ERC project leaders, introducing projects on the basis of the Marie Skłodowska-Curie seal of excellence, co-financing of bilateral co-operation, promotion of co-operation between research organisations in the Horizon 2020 calls and supporting international associations, promotion of Slovenian science abroad and integration of scientific achievements.

Research infrastructure: co-financing of infrastructure programmes, science and popular science periodicals and scholarly monographs, founder obligations, the COBISS system and other library and information activities and infrastructures, international journals and data collections, and research equipment.

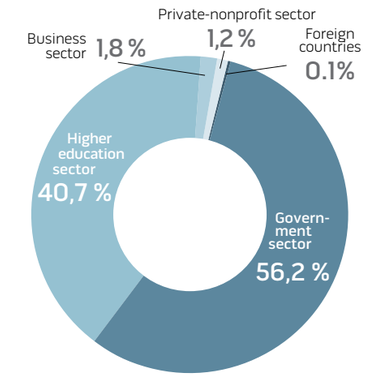
Distribution of Agency funds per discipline [1]



Distribution of Agency funds per mechanism section



Distribution of Agency funds per activity sector [2]



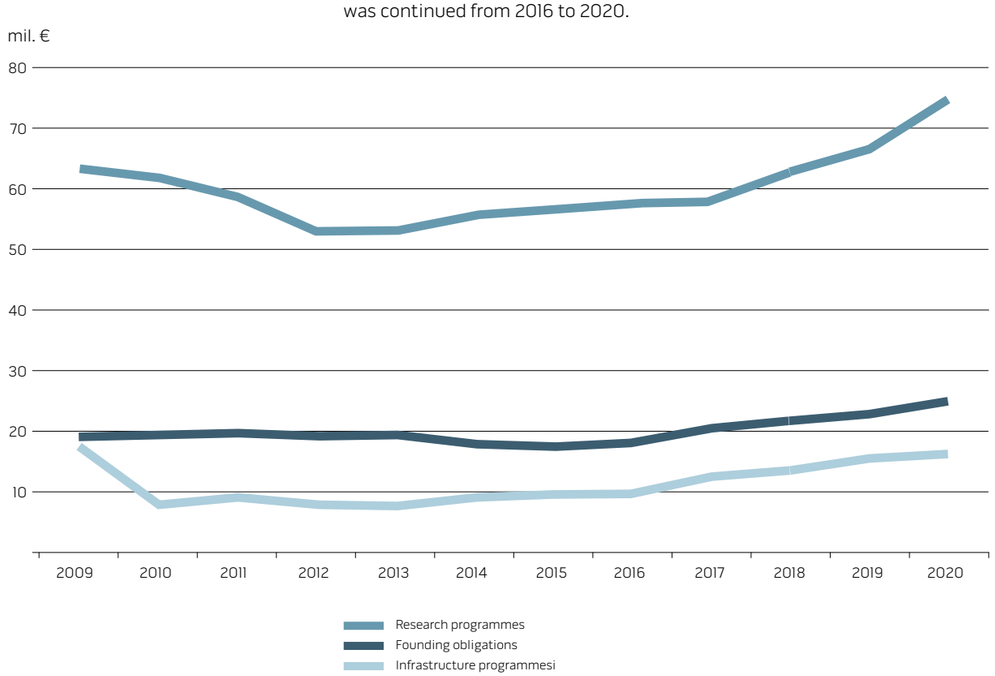
[1] Funds for founder's obligations, infrastructural programmes, international promotion of science, the operation of Slovenian associations around the world, promotion of applications to EU projects, OSIC and foreign journal databases cannot be broken down per discipline and are therefore not taken into account.

[2] According to the Frascati methodology, research and development organisations and research and development units are divided into four to five sectors according to core activities, economic and legal status and source of financing:
- business enterprise sector: for-profit and non-profit companies, public enterprises within the framework of economic public services and private non-profit institutes;
- state sector: non-financial companies with public oversight, other national authorities, other local authorities and direct budget recipients;
- private non-profit sector: private non-profit institutions serving private citizens and households;
- higher education sector: universities and other institutions carrying out tertiary education programmes, research institutes, experimental units and clinics;
- foreign entities sector: institutions, international organisations and individuals outside the political borders of the Republic of Slovenia.

Institutional financing

Research programmes	EUR 74.9 million
Founder obligations	EUR 25.0 million
Infrastructure programmes	EUR 16.2 million

Research programmes, infrastructure programmes and founder obligations comprise a stable aspect of research financing. Due to austerity measures, the financing of research programmes in 2012 was reduced by 10% compared to the previous year. In 2014 and 2015, the Agency made use of long term stable financing to ameliorate the reduction of funding from 2012, allowing for an increase in research programme funding. The trend of growth in funding of research programmes, infrastructure programmes, and founder obligations was continued from 2016 to 2020.



Research programmes

In 2020, the Agency paid EUR 74.9 million for the co-financing of research programmes, which represents 36.2 % of the total budget. In 2020, 302 programmes were financed, of which 65 programmes were in the field of natural sciences, 88 in engineering sciences, 36 in medical sciences, 21 in biotechnical sciences, 48 in the social sciences, and 44 in the humanities.

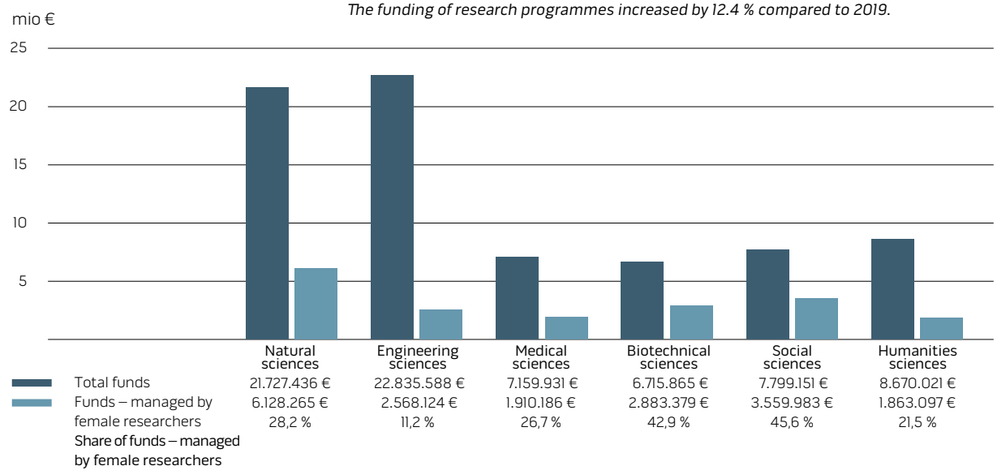
Invitation and call in 2020

In June 2020, the Agency has published a public call for applications to increase the funding of research programmes related to the COVID-19 pandemic. The COVID-19 public call was intended for public research organisations, established by the Republic of Slovenia, and research organisations awarded a concession for carrying out research programmes that had financing approved for 2020. The subject of the public invitation is additional research programme financing for implementing public service in the field of research with the purpose of developing new scientific findings that would contribute to COVID-19 management, treatment, and prevention, more specifically in five themes, organised into two groups. Based on the public invitation, 65 research programmes were approved for an increase of financing.

Distribution of funding per activity sector in EUR

State sector	39,854,646
Higher education sector	33,911,833
Business enterprise sector	910,125
Private non-profit sector	231,387
Skupaj	**74,907,991**

The funding of research programmes increased by 12.4 % compared to 2019.



Infrastructural programmes and founder's obligations

Founder's obligations are obligations the founder has towards public research and infrastructure institutes, whereby the Agency covers fixed operation costs related to the core research or infrastructure activity. EUR 19.0 million was paid for founder obligations in 2020, which represents a decrease of 17.4 % compared to 2019.

Founder obligation funding per activity sector in EUR

State sector	23,705,166
Higher education sector	1,310,650
Total	**25,015,816**

Infrastructural programmes support research work. The central role of research infrastructure is to ensure a high quality research environment. EUR 16.2 million was paid for infrastructure programmes in 2020, which is 3.8 % more that in 2019.

Infrastructure programme funding per activity sector in EUR

State sector	10,909,919
Business enterprise sector	169,687
Higher education sector	4,030,281
Private non-profit sector	1,126,201
Total	**16,236,088**

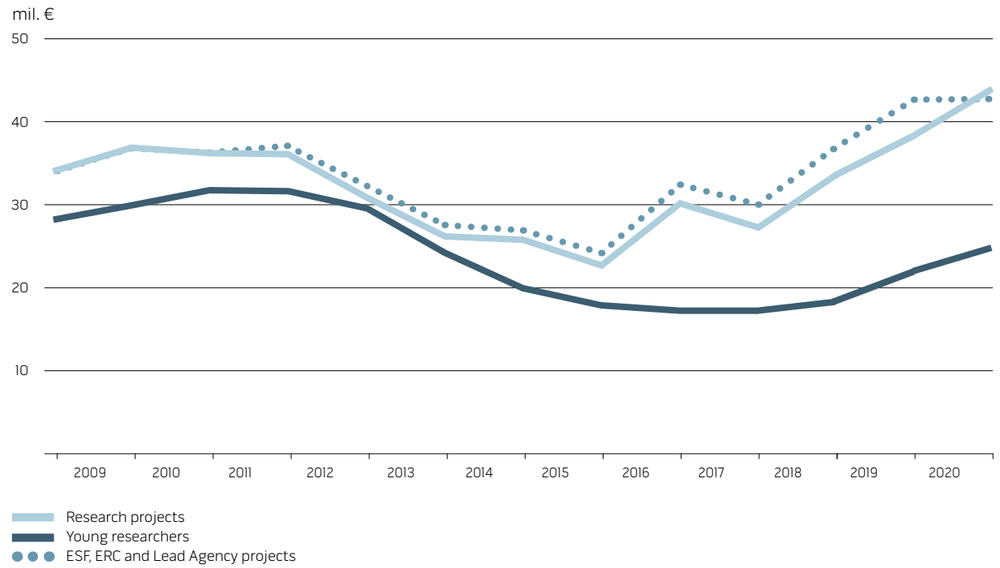
Competitive financing

Research projects EUR **43.9** million

Junior researchers EUR **24.7** million

In 2019, the funding of research projects increased by 13.3 % compared to the year before. A significant decrease in funding was recorded in 2012, when the Agency did not finance any new research projects due to austerity measures. Financing of research projects increased by 18.8 % between 2011 and 2020.
The increase in funding for research projects in 2016 was due to austerity measures in previous years and consequent delays in the start of financing for research projects, particularly in 2013, which meant that 2016 saw the financing of more projects than usual in the past years.
Since 2010, there has been a continued trend of reduced funding for junior researcher training; in 2017, the funding decreased by 0.9 % compared to the year before. In 2020, the funding increased by 12.8 % compared to the previous year.

Funding for research projects and junior researchers

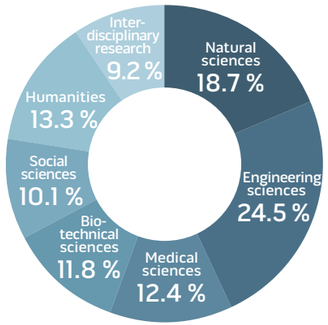


Research projects

In 2020, the Agency co-financed research projects in the amount of EUR 43.9 million. Project funding represents 27.6 % of the Agency's total budget and is higher than in 2019 by 6.7 percentage points.

Basic research projects	EUR 31.8 million
Applied research projects	EUR 6.6 million
Postdoctoral research projects	EUR 3.8 million
Targeted research programme projects	EUR 1.7 million

Funding for research projects per discipline



Basic and applied research projects

In 2020, with finances from the national budget, the Agency co-financed 515 basic research projects, with a total value of EUR 31.8 million. Funding increased by 14.2 % compared to 2019. Junior researchers (up to 10 active years after defending their doctoral thesis) conducted 62 basic projects, and received 12.8 % of the funding allocated for basic research projects.
In 2020, with finances from the national budget, the Agency co-financed 101 applied research projects, with a total value of EUR 6.60 million, which is 3.2 % more than in 2019?
Junior researchers conducted 10 applied projects and received 10.5 % of the funding allocated for applied research projects.

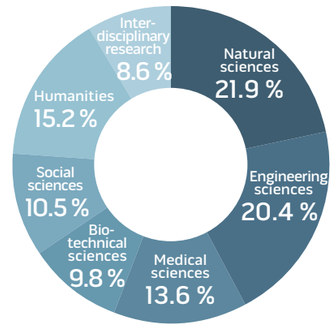
The evaluation methodology of applications on public calls dictates that among co-financed applied science projects, at least 30 % must be projects in the field of engineering sciences, at least 20 % in the field of biotechnical sciences, at least 10 % in the field medical sciences and social sciences, and at least 5 % in the field of natural sciences. The structure of all (co)financed projects closely follows the implementation of the aforementioned methodology.

Discipline	Basic and appl. projects in mil. EUR	Female principal investigators	Junior principal investigators	Of those female researchers
Natural science	7,3	36,4%	11,6%	36,0 %
Engineering	9,7	29,6 %	16,4 %	21,0 %
Medicine	4,6	28,6 %	10,8 %	43,6 %
Biotechnology	4,1	25,3 %	4,9 %	40,3 %
Social sciences	3,7	19,7 %	4,0 %	37,1 %
Humanities	5,2	31,5 %	14,0 %	39,1 %
Interdisciplinary research	3,7	21,8 %	3,4 %	21,9 %
Total	**38,4**	**36,8 %**	**12,4 %**	**33,8 %**

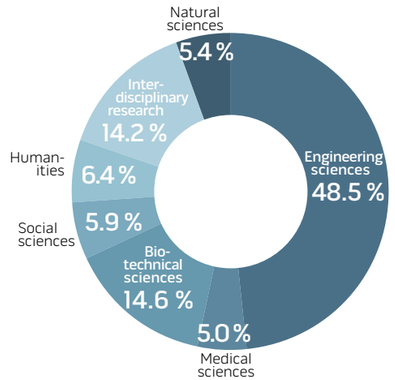
The funding of basic and applied research projects, and project shares, for projects led by female researchers and young researchers. Data about the share of funding for projects lead by young female researchers are presented in the last column.

The evaluation methodology of applications on public calls dictates that at least 20 % of the chosen projects must be led by junior researchers (researchers with up to 10 active years after defending their doctoral thesis). This is how the Agency promotes the integration of young scientists into research activities.

Funding for basic research projects per discipline



Distribution of applied research project funding per discipline



Postdoctoral projects

In 2020, with funds from the national budget, the Agency financed 104 postdoctoral projects in the total amount of EUR 3.8 million, which represents an increase of 7.8 % compared to 2019.

The evaluation methodology of applications on public calls dictates that at least 10 % of all projects within each discipline must be at postdoctoral level.

The funding of postdoctoral projects, and project shares, for projects lead by female researchers

Discipline	Funding in EUR	Share – female principal investigators
Natural science	800.539	24,0 %
Engineering	940.878	28,7 %
Medicine	597.827	94,8 %
Biotechnology	239.145	78,3 %
Social sciences	347.161	58,8 %
Humanities	552.331	59,3 %
Interdisciplinary research	353.471	55,9 %
Total	**3.831.353**	**50,8 %**

2019 call

The funding of research projects, which were accepted for co-financing on the basis of the 2019 call, began in 2020. The funding of research projects for which the Agency published the co-financing of public calls in 2020, will begin in 2021.

Targeted research programme projects (CRP)

In 2019, funds for co-financing targeted research programme projects amounted to EUR 1.9 million or 46.2 % more than in 2019.

In 2020, 136 projects received funding in the framework of targeted research programmes.

The financing of targeted research project programmes enables research support to interested ministries and other users, for the design of strategic targets of Slovenian development, and with decisions about fundamental development tasks, which are imperative for the increase of Slovenian competitiveness, adaptability and innovation. The projects are thematically directed based upon the proposals of ministries and parties from the private sector, who are competent to act in the public interest.

In 2020, the Agency published three calls for targeted research programmes, specifically:

- Public call for the selection of research projects within the framework of the "Zagotovimo.si hrano za jutri" targeted research programme for 2020;
- Public call for the selection of research projects within the framework of the "CRP COVID-19" targeted research programme for 2020;
- Public call for the selection of research projects within the framework of the "Zagotovimo.si hrano za jutri" targeted research programme for 2020-II.

In June 2020, the Agency, with the approval of the Ministry of Agriculture, Forestry and Food, and based on the applicable legal acts, published a public call for the selection of research projects within the framework of the targeted research programme titled "Zagotovimo.si hrano za jutri" (Ensuring food for tomorrow).
The subject of the Public call for the selection of research projects within the framework of the "Zagotovimo.si hrano za jutri" targeted research programme were topics and themes in the framework of the following focal points::

- Slovenian food security
- Competitiveness in food production and renewable natural resources
- Sustainable management of natural resources
- Rural development

The call, concluded in October 2020, saw 31 projects accepted for co-financing.

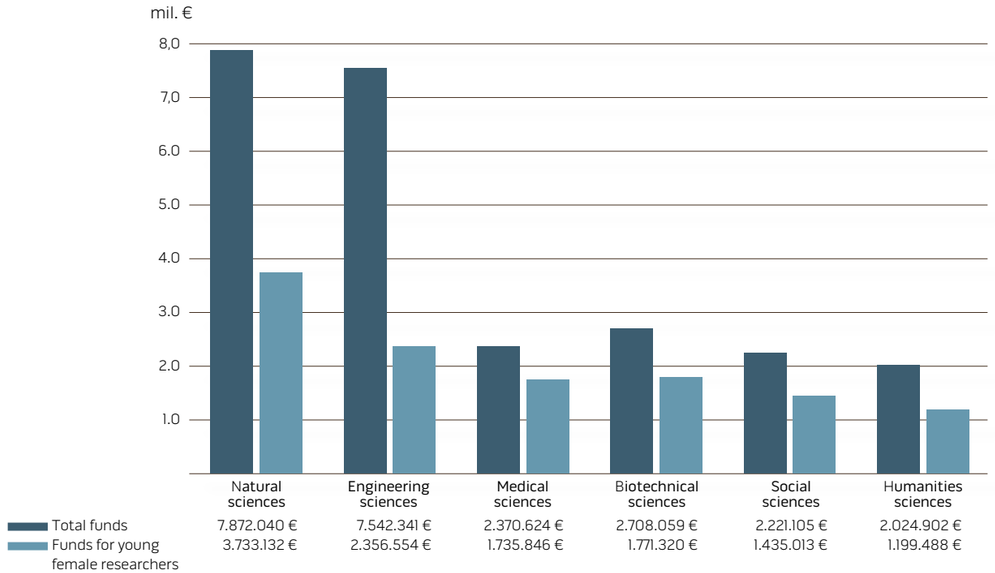
In July 2020, the Agency, with the approval of the Ministry of Health and the Ministry of Defence, and based on the applicable legal acts, published a public call for the selection of research projects within the framework of the targeted research programme titled "CRP COVID-19" for 2020.

The call was concluded in September 2020 and saw 8 projects accepted for co-financing.

Junior researchers

In 2020, the Agency financed the training of 1003 junior researchers, with a total funding of EUR 24.7 million, which represents 11.9 % of the Agency's total budget; the amount of junior researcher funding in 2020 was the same as in 2019. The Agency enables junior researchers to take part in research during their postgraduate studies on the basis of temporary employment contracts. Their wages, social contributions, and material and service costs are financed by the Agency. The average annual financing for one junior researcher amounts to approximately EUR 30,000. Training funds are allocated for a temporary period, not exceeding four years of a doctoral study programme. The purpose of the programme is to rejuvenate the research staff and thus promote new ideas and approaches. The junior researcher programme is a source of highly trained and motivated employees, who represent a large potential for the Slovenian economy and other socially important areas. Within the framework of the programme, approximately eight thousand junior researchers were trained between 1985 and 2016.

Funding for junior researchers



In 2020, three young researchers received rewards for the early completion of training.

Promotion of young mentors

The Agency rules state that 25 % of the accepted mentors of junior researchers within research organisations must be young mentors.

2020 call

In January 2020, the Agency published a call for the allocation of mentorship positions within research programmes, leading to 230 mentorship positions being allocated among 180 research programme applications: 68 in the natural sciences, 72 in engineering, 25 in medicine, 24 in biotechnology, 21 in the social sciences, and 20 in the humanities.

Scientific literature

Scientific literature **EUR 2.06 million**

International publications and data collections **EUR 5.44 million**

The Agency co-finances electronic access to the latest scientific databases and the purchase of international scientific literature in order to ensure the availability and accessibility of international scientific and expert information for the purposes of research, educational and development activities. The literature is publicly available in all libraries, research organisation, and via the COBISS system. The Agency also co-finances science and popular science publications on the basis of a public call, with the aim of enabling the publication of those popular science publications which are important for the promotion of interest in science and technology among the general public, particularly among young people. The Agency also co-finances the publication of scholarly monographs important for the development of Slovenian scientific terminology, intended for presenting scientific achievements and findings in Slovenia and abroad, and for promoting scientific culture. Co-financing of the scientific press, including domestic science and popular science publications, commanded a sum of EUR 1.34 million in 2020, while EUR 0.44 million was paid for scholarly monographs.

International activities

The ERC complementary scheme **EUR 2.56 million**

Within the complementary scheme, applicants from Slovenian research organisations who have been positively evaluated on European Research Council (ERC) calls, but were not selected for co-financing, have the possibility of applying for Agency funding with an adapted project, which, based on its objectives and scope of work, takes into account the time required to complete the adapted project as well as the amount of available funding. The Agency co-finances adapted projects, which are primarily carried out in Slovenia, based on a proposal from the Scientific Council, and taking into account the available funding.

The purpose of the complementary scheme is to co-finance adapted research projects that have exceeded the determined success threshold in the process of an international evaluation, to ensure that the applicants have the appropriate conditions to further their scientific excellence and the initial idea of the research project. At the same time, the aim of the public call is to enable the leader of the adapted research project to submit an application for the ERC call after the project in question is completed. Within the Agency complementary scheme, funding was approved for six out of a total of fourteen recipients of ERC projects in Slovenia.

In 2020, the Agency co-financed 33 projects within the complimentary schemes framework, of which 16 were in the natural sciences (45.4 % of funding), 13 were in engineering sciences (43.1 % of funding), two in the social sciences (7.5 % of funding), and two in the humanities (4.0 % of funding).
Organisations in the state sector received 65.3 % of funds, those in Higher education received 32.2 % of funds, while those in the business sector were allocated 2.4 % of funds.
The calls are aimed at individual projects for excellent frontier research in all disciplines and are among the most competitive globally; the total success rate in the call is approximately 10 %. The calls are open to all researchers, regardless of their current place of employment, with the condition that the acquired ERC project is conducted within Europe.
The frontier research evaluation system established by the ERC is considered to be an exemplary "peer review" system, and is recognised by basic research funding agencies worldwide.

The European Research Council was established in 2007. It is currently working within the Horizon 2020 programme, and comprises 17 % of the budget. Since its inception, the ERC has financed more than 7,000 projects, selected from more than 65,000 applications. Among the recipients of ERC funding are six Nobel laureates. In 2020, the total budget of the European Research Council amounted to approximately EUR 2.2 billion. More than 70 % of the projects evaluated by an independent study resulted in scientific breakthroughs or major progress, while 2 5 % contributed to important improvements.
Source: https://erc.europa.eu/

The ERC publishes an annual work programme that acts as the foundation of three calls for the current year:

- **Starting Grant** – enabling the start of independent research (2-7 years after the award of a doctoral degree);
- **Consolidator Grant** – enabling the consolidation of independent researches (7-12 years after the award of a doctoral degree);
- **Advanced Grant** – for renowned researchers.

The ERC also enables applicants to apply for two additional calls that are not eligible for the complementary scheme:

- **ERC Proof of Concept** – constitutes a bridge between research and the earliest stage of market innovation. This call is open to researchers who have received ERC support.
- **Synergy Grants** – intended to support two to four excellent researchers and their groups in joining their complementary knowledge and resources to tackle demanding research projects together. The aim is to make new discoveries where different scientific disciplines overlap as well as use new methods and techniques in research.

The call of the European Research Council – ERC

In 2020, EUR 2.4 million of funds available to researchers who are at the beginning of an independent research career (a Starting Grant) were awarded to Assistant Professor Dr. Matic Lozinšek from the Jožef Stefan Institute. The objective of a five-year project titled "Challenging the Oxidation-State Limitations of the Periodic Table via High-Pressure Fluorine Chemistry" is to research the reactions of fluorine under extremely high pressures, created in cells with diamond anvils.

The following researchers were also successful at the ERC call for renowned researchers in 2020:

Dr. Peter Križan from the Jožef Stefan Institute with a five-year FAIME (Flavour Anomalies with advanced particle Identification Methods) project, which shall be focused on the search for new phenomena in the fundamental particle physics and the study of some rare B particle meson decays. The project shall be partially carried out at the Faculty of Mathematics and Physics in Ljubljana.

Dr. Igor Muševič from the Jožef Stefan Institute with a five-year LOGOS (Light-operated logic circuits from photonic soft-matter) project, with the objective of developing a new technology for producing logical circuits made of liquid crystals that shall operate exclusively on the basis of light. The project shall be partially carried out at the Faculty of Mathematics and Physics in Ljubljana.

Dr. Matej Praprotnik from the National Institute of Chemistry with the MULTraSonicA: Multiscale modelling and simulation approaches for biomedical ultrasonic applications project with the objective of understanding the ultrasonic control of medicine delivery and cell activation.

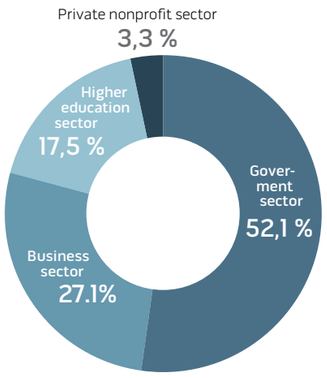
The lead agency scheme EUR 2.9 million

The Agency promotes international scientific research via the lead agency scheme. By means of a co-operation agreement between the agencies of various countries, researchers are able to apply collectively, as a joint research project, under the auspices of one of the agencies (the lead agency), which is tasked with implementing the review process. If the peer review process of the application is successful and the lead agency proposes co-financing of the project, then another agency takes on the co-financing of the researcher from their own country without conducting an additional review process. In 2020, the Agency co-financed 54 projects within the lead agency scheme, of which 26 were in the natural sciences (52.5 % of funding), eight in engineering sciences (14.3 % of funding), five in medical sciences (9.5 % of funding), four in biotechnical sciences (6.2 % of funding), five in the social sciences (7.9 % of funding), and six in the humanities (9.5 % of funding). Institutions in the Higher education sector received 57.4 % of funds, institutions in the State sector 41.3 % of funds, while those in the Higher education sector were allocated 1.3 % of funds.

In 2020, projects were conducted in co-operation with:

- The Austrian Fund for Scientific Research – Fonds zur Förderung der wissenschaftlichen Forschung, FWF;
- The Research Foundation Flanders, FWO;
- The Hungarian National Research, Development and Innovation Fund, NKFIH;
- The Swiss National Science Foundation, SNSF;
- The Croatian Science Foundation – Hrvatska zaklada za znanost, HRZZ.

Distribution of funds



International bilateral projects EUR 0.8 million

In 2020, international bilateral scientific co-operation was conducted by the co-ordinated efforts of the competent ministry and the Agency.

Co-operation was conducted with 14 countries – Austria, Bosnia and Herzegovina, China, Germany, France, Croatia, Hungary, Japan, Montenegro, Serbia, Russia, Turkey, and the United States of America. The majority of funds were allocated to co-operation with the United States of America (31.9 %).
The Agency also co-operates with the French Commissariat for alternative and atomic energy (CEA). This co-operation is conducted via a public call, the subject of which is the co-financing of international scientific research projects lasting for a period of two years. Based on five public calls in 2020, 26 collaborative research projects were co-financed in the fields of new energy technologies, nuclear energy, adaptation to climate change, fundamental physics, life science, and global safety.
Co-operation with CEA in 2020 was co-financed in the amount of EUR 534,840 which represents an increase of 1.1 % compared to 2019.

Horizon 2020 public call application incentive EUR 0.6 million

The Agency encourages the participation of Slovenian research organisations in applications to the Horizon 2020 programme. This allows for a continuous open public call to project applicants under the EU Horizon 2020 Framework Programme for Research and Innovation.

One-time payment towards the costs of project application is available to research organisations that are entered into the registry of research organisations which is maintained by the Agency, on the day of submitting the application for the public call, and that act as co-ordinators or partners in a project that applied for funding on a call within the Horizon 2020 Framework Programme for Research and Innovation. A sum of EUR 2,000 is contributed to help cover the costs incurred by the preparation and application of a project that has been co-ordinated and applied to the international consortium by a Slovenian research organisation, whereas a sum of EUR 1,000 is contributed toward costs incurred by a Slovenian research organisation, which has submitted a project independently to the international consortium, assuming the call was anticipated by the European Commission.

Support for the promotion of science abroad and for membership in international associations EUR 0.3 million

The Agency co-finances the promotion of Slovenian science and knowledge by supporting active co-operation in events that are organised by renowned international associations, international organisations or the European Commission. Additionally, the programme facilitates co-operation with Slovenian research organisations and researchers from neighbouring states, as well as co-operation with Slovenian researchers working abroad. The call includes innovative activities for the promotion of Slovenian science abroad with the aim of supporting new breakthrough ideas in the field of science promotion and communication. In 2020, the Agency co-financed the following innovative activities:

- STA science – online discussions and stories;
- SiNAPSA, Slovenian neuroscience association – Misli na možgane (MnM) (Think of the brain);
- Kvarkadabra – Innovative tool for promoting science;
- Podcasts for the promotion of science – Metamorfoza and Meta PHoDcast + a series of records #Odprimo znanost (#Let's open science);
- Tromba portal – Pitia promotion activity – synergy of different viewpoints for the advancement of modern society;
- Znanost na cesti (Science on the road).

The Agency also co-finances the memberships of Slovenian scientific associations in international scientific associations and the work of Slovenian representatives elected in international scientific associations as presidents, vice-presidents, general secretaries, and members of management bodies.

THE AGENCY'S INTERNATIONAL COOPERATION – HIGHLIGHTS

ARRS is in the group of 18 agencies which shall enable researchers joint application, based on the principle of mutual recognition of procedures

In the framework of the Science Europe association, eighteen agencies have prepared an agreement, determining the details of co-operation in the field of co-financing joint research projects: AKA (Finland), ANR (France), ARRS (Slovenia), DFG (Germany), FCT (Portugal), FNR (Luxembourg), FNRS (Belgium), FORMAS (Sweden), FWF (Austria), FWO (Belgium), GACR (Czech Republic), HRZZ (Croatia), NCN (Poland), NWO (Netherlands), RCN (Norway), SFI (Ireland), UKRI (Great Britain), and SNSF (Switzerland, also the work group leader). The multilateral lead agency funding scheme builds on a multitude of bilateral lead agency schemes and expands the collaboration between agencies in several countries.

The new funding scheme enables researchers to submit a collaborative research project proposal with one of the agencies (the lead agency), which carries out the evaluation procedure for such collaborative project proposals. The proposal can, in the financial part at the start-up, include a maximum of three (co)financing agencies.

The lead agency funding scheme significantly reduces the administrative workload that the applicants in a collaborative research project proposal need to otherwise perform, as the evaluation procedure for the collaborative research project proposal is carried out by one of the agencies, i.e. the lead agency.

Such collaboration also means mutual recognition of compliance of evaluation procedures and an establishment of the principle of trust, based on which the lead agency schema is built.

Eighteen agencies, directly co-operating in the MLA work group, shall have the opportunity to immediately sign the agreement, as at the time of preparation of the agreement and implementation instructions, the agency had verified the operation and evaluation procedures of individual agencies. They recognised sufficient alignment among them and were able to approach to the conclusion of such agreement with trust.

More information is available in the Events and News section.

ARRS guiding principles for international co-operation: the opening of opportunities for closer international co-operation in the field of science (ARRS operation and development strategy 2016-2020)

First stage: establishing and strengthening international connections

Incentives:

Bilateral co-operation – mobility incentives, concluded agreements between the Republic of Slovenia and 39 countries across the globe
COST actions – strengthening international connections
Horizon 2020 – contributions towards application costs
Scholarships for visits to ERC project holders (since 2016)
3 to 6-month visits to ERC project holders
After the visit, the researcher visiting the ERC project holder, must submit an application to one to three ERC calls (the time period is determined in the call).

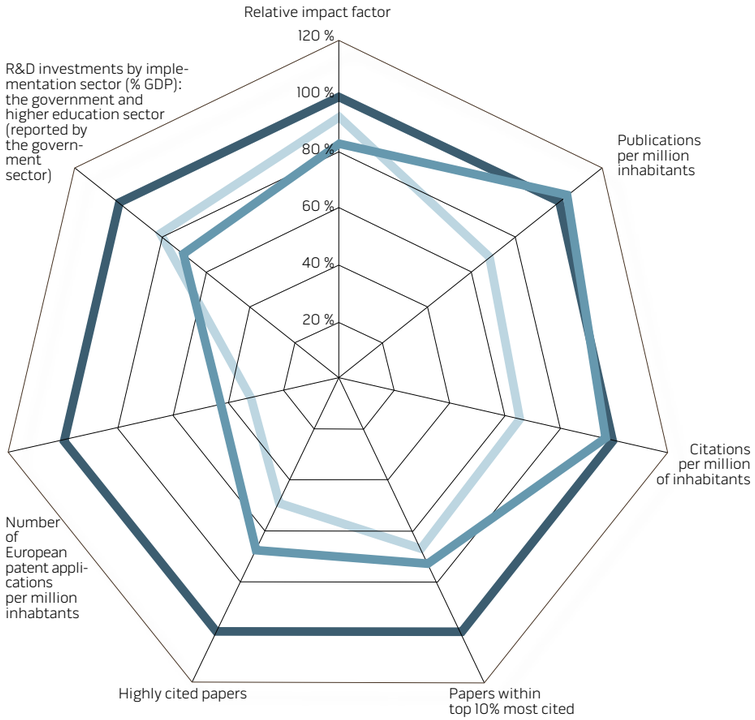
Second stage: incentives for closer international co-operation in the field of science

Possibilities - public calls and invitations:

1. **Lead agency scheme – bilateral research projects**
   Austria (FWF), Hungary (NKFIH), Belgium – Flanders (FWO), Switzerland (SNSF), Croatia (HRZZ)
2. **ERC complementary scheme (since 2011)**
   Possibility for adapted research projects that have achieved a grade exceeding a given threshold in ERC calls to be accepted for financing as national research projects (duration of up to 3 years, funding up to EUR 200,000)
3. **Marie Skłodowska-Curie seal of excellence – MSCA (since 2017)**
   Applicants for individual scholarship calls (MSCA IF) that receive a seal of excellence in the evaluation procedure (grade of 85 % or over), can obtain funding as national research programmes (duration of up to 2 years, funding up to EUR 77,000)
4. **ERA projects – international calls of ERA networks**
   JPI Urban Europe (since 2015)
   NORFACE (since 2005)
   PRIMA (since 2018)

More information: http://www.arrs.si/sl/medn/

INTERNATIONAL COMPARISONS



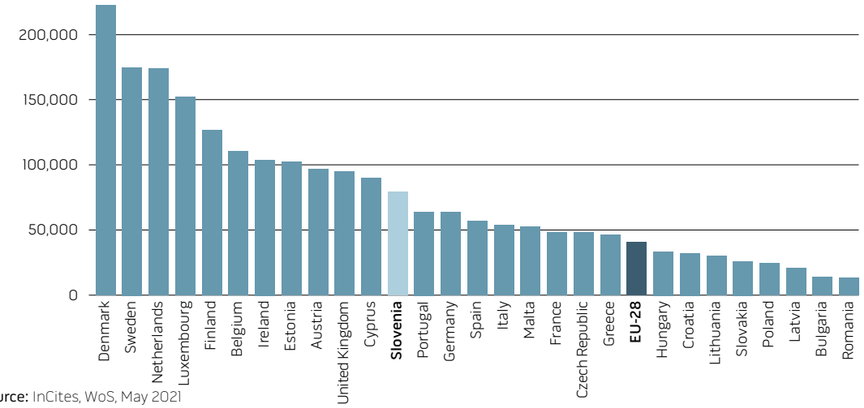
The diagram shows the majority of standard bibliometric and other quantitative indicators that are used to measure research activities across the world and that are also included in the Resolution on the research and innovation strategy of Slovenia 2011-2020. The scores for Slovenia are shown relative to the EU country ranking 9th (upper third of the countries). For comparison, data for the EU country ranking 14th (upper half of the countries) is also given.

Source: InCites, Thomson Reuters/Science Metrix/Innovation Union Scoreboard/Eurostat

Citations

According to number of citation per million inhabitants, Slovenia ranked 12th in the 2016–2020 period with 93,998 citations. In the same period, the number of citations per million inhabitants was the highest in Denmark, followed by Sweden, Luxembourg and the Netherlands.

Number of citations per million inhabitants for EU countries in the 2016-2020 period

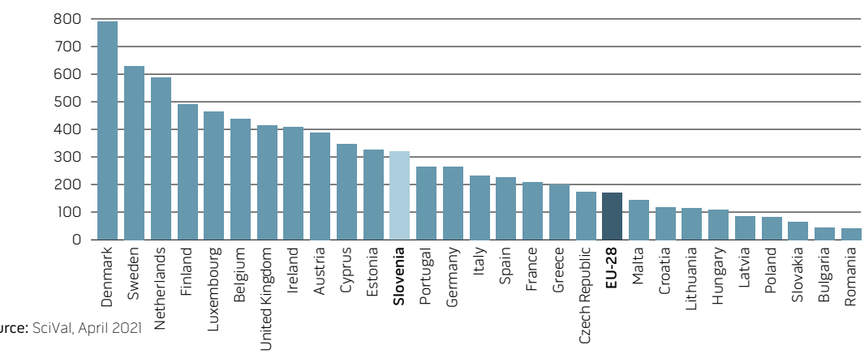


Source: InCites, WoS, May 2021

Published works among the 10 % of the most cited

An established bibliometric indicator for international comparisons is the number of published works that rank among the 10 % of the most cited works in the world for the given field of research. This encompasses works published in journals indexed in the Scopus bibliographical database. A four year citation window is taken into account, including the year of publication and the three subsequent years. Since 2004, Slovenia has exceeded the EU average in terms of 10 % of the most cited published works per million inhabitants. According to the latest data for 2017, Slovenia ranks 12th among the EU member states.

The number of published works ranking among the 10 % of the most cited works per million inhabitants for 2017 for EU member states

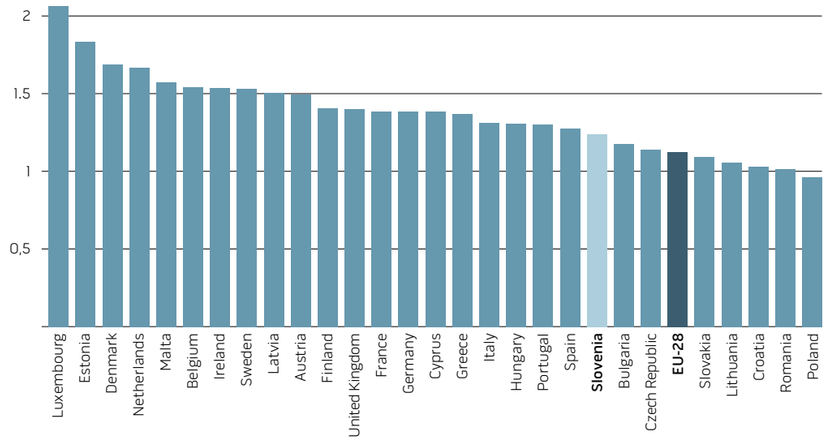


Source: SciVal, April 2021

Relative impact factor

The relative impact factor is the standard international bibliometric indicator measuring the ratio between the number of received citations and the number of published works in a given country compared to the global average impact factor for an individual field of research. In terms of the relative impact factor, Slovenia ranks 23rd among EU member states. Despite the above average increase of the impact factor, the value of this indicator remains below the European average.

Relative impact factor for EU countries in the 2016-2020 period



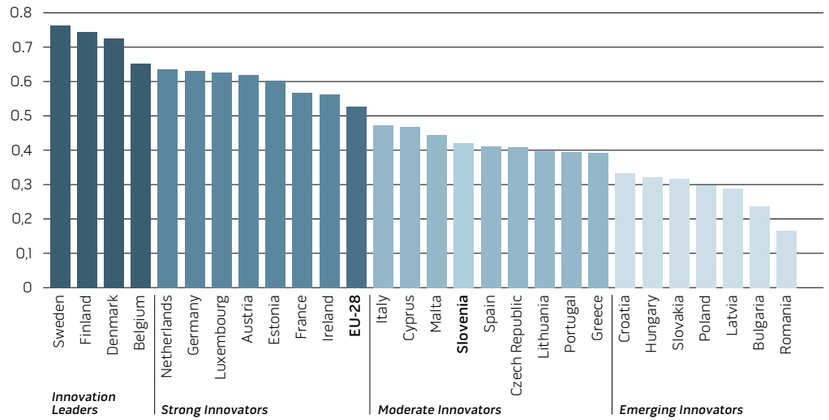
Data for 2020 shows that the relative impact factor is higher than in 2019, which amounted to 1.24. In 2020, Slovenia was just above the European average (1.13).

Source: InCites, WoS, May 2020

Innovation index

The joint innovation index (Innovation Union Scoreboard) provides an overview of the innovation activities of individual countries. It is comprised of over twenty indicators that include data on the educational structure, openness and excellence of the research system, financing, support and investment, connections, entrepreneurship and intellectual capital. In terms of the level of innovativeness, the countries are divided into four groups: the first group being innovation leaders, the second being strong innovators, the third being moderate innovators, and the fourth being emerging innovators. Given the listed indicators, Slovenia is among the following countries and ranks 16th among EU member states.

Innovation index for EU countries in 2020



International comparisons and other analyses are published on the following website: https://www.arrs.si/sl/analize/.

Source: Innovation Union Scoreboard, 2021

Strategic orientations of the Agency's operation and development:

- sound implementation of activities according to the legal basis, Decision Establishing the Slovenian Research Agency, and applicable national strategic documents;
- stransparency and responsiveness;
- soptimisation of existing instruments and setting-up pilot instruments;
- smonitoring the effects of the implementation of activities;
- sinternational integration and comparability;
- stransition to fully electronic services;
- scommunication with the public and science promotion based on three values: openness, responsiveness, providing valuable information.

Internal organisational units

Director's office

The Director's office carries out specialised, advisory, co-ordination and administrative-technical tasks, and co-ordinates work on joint tasks with the Agency's internal organisational units and other Agency bodies. The Director's office is also responsible for communication with the public.

Department of Research Programmes and Junior researchers, Analysis and Monitoring

This department evaluates and selects research programmes and carries out tasks related to the junior researchers programme. It analyses and monitors the development of scientific research activities and actively develops the area of science promotion. Department activities include international co-operation in the Norface network and the Urban Europe joint programming initiative. Department activities also include the promotion of science.
Head of the Department: ***Marko Perdih***, Deputy Director

Department of Research Projects

This department carries out tasks in the field of evaluation and selection of research projects. Within its scope of operation, it organises the procedures for substantive monitoring and control of co-funding, implementation and attainment of research project objectives. The main activities of this department are the launch of the call for proposals to receive co-funding for research projects and the launch of the call for proposals to receive co-funding for the Targeted Research Programmes projects.
Head of the Department: ***Simon Ošo***

Department of Research Infrastructure and International Co-operation

This department carries out tasks in the field of research equipment and infrastructure programmes, science and popular science periodicals and scholarly monographs, international scientific research co-operation, the promotion of science abroad, and the involvement of researchers in the activities of international scientific associations. Its tasks range from activities within the mechanism of leading agencies and the seal of excellence, to activities related to the fostering of participation in the calls for proposals for European research programmes, setting up the complementary scheme in connection with calls for proposals of the European Research Council, and the hosting of researchers from other countries.
Head of the Department: ***Mojca Boc***

Department of Legal and General Affairs

The Department of Legal and General Affairs carries out tasks in the field of law and labour law procedures and conducts administrative procedures regarding access to public information and keeping of the private researchers register. The department is also responsible for keeping the register of research and development activity operators, and carries out tasks regarding personnel and human resource management. In addition, it carries out public tendering procedures and other procedures related to the takeover of resources and services and is responsible for ensuring the maintenance of Agency offices and equipment. The department also carries out the main office tasks, as well as the tasks related to storing of documentary material and maintenance of the archive.
Head of the Department: ***Katarina Hren***

Department of Finance and Accounting

The department carries out tasks related to the Agency's financial operations. It is responsible for planning, implementing, record keeping, and reporting on funding for scientific research activities, as well as the Agency's programming tasks and operation. It ensures the Agency's solvency. The department is responsible for putting in place payment, recovery, and control mechanisms; it also carries out accounting tasks and co-ordinates the conclusion of joint contracts with research activity operators.
Head of the Department: ***Mojca Kastelc Selan***

Department of Information Technology

The Department of Information Technology lays the expert groundwork for the determination and implementation of the Agency's information policy, provides information support for business processes and co-ordinates the development of information and communication infrastructure. The department manages projects for the installation, operation and maintenance of hardware, system software and basic user interface software tools.
Head of the Department: ***Dragan Nedeljković***

Overview of financing in 2020 per programme item in accordance with the accrual principle

	Realisation in 2020 (in EUR)
FOUNDER'S OBLIGATIONS AND INFRASTRUCTURE PROGRAMMES	41,251,904
Founder's obligations for PRO	19,015,496
Infrastructure programmes – material costs	11,248,084
Reimbursement of work-related costs	6,000,321
Infrastructure programmes – salaries	4,988,004
RESEARCH PROGRAMMES AND PROJECTS	122,131,235
Research projects	38,364,412
Research programmes	74,907,991
ERA projects	288,662
ESF and ERC projects	6,428,510
Targeted research programmes – competitiveness	1,706,784
Open access	234,875
Targeted research programmes	200,000
TRAINING AND DEVELOPMENT OF SCIENTISTS	28,578,779
Junior researchers	24,747,425
Postdoctoral projects	3,831,353
RESEARCH EQUIPMENT	5,826,849
Research equipment	5,826,849
SCIENTIFIC LITERATURE, MEETINGS AND OSIC	7,515,510
Slovenian popular science periodicals	90,000
Slovenian science periodicals	1,251,955
Scholarly monographs	441,825
Foreign periodicals and databases	5,449,999
OSIC – Central Specialised Information Centres	281,731
INTERNATIONAL SCIENTIFIC CO-OPERATION	1,518,128
Co-operation with the EU (CEA)	681,793
International projects, bilateral co-operation	76,702
Promotion of applications to EU projects	567,000
International science promotion	164,013
Operation of Slovenian science associations abroad	28,620
Total:	**206,822,405**

The overview of funding per individual year is available on the following website: www.arrs.gov.si/sl/finan/

Public calls and tenders, published in 2020

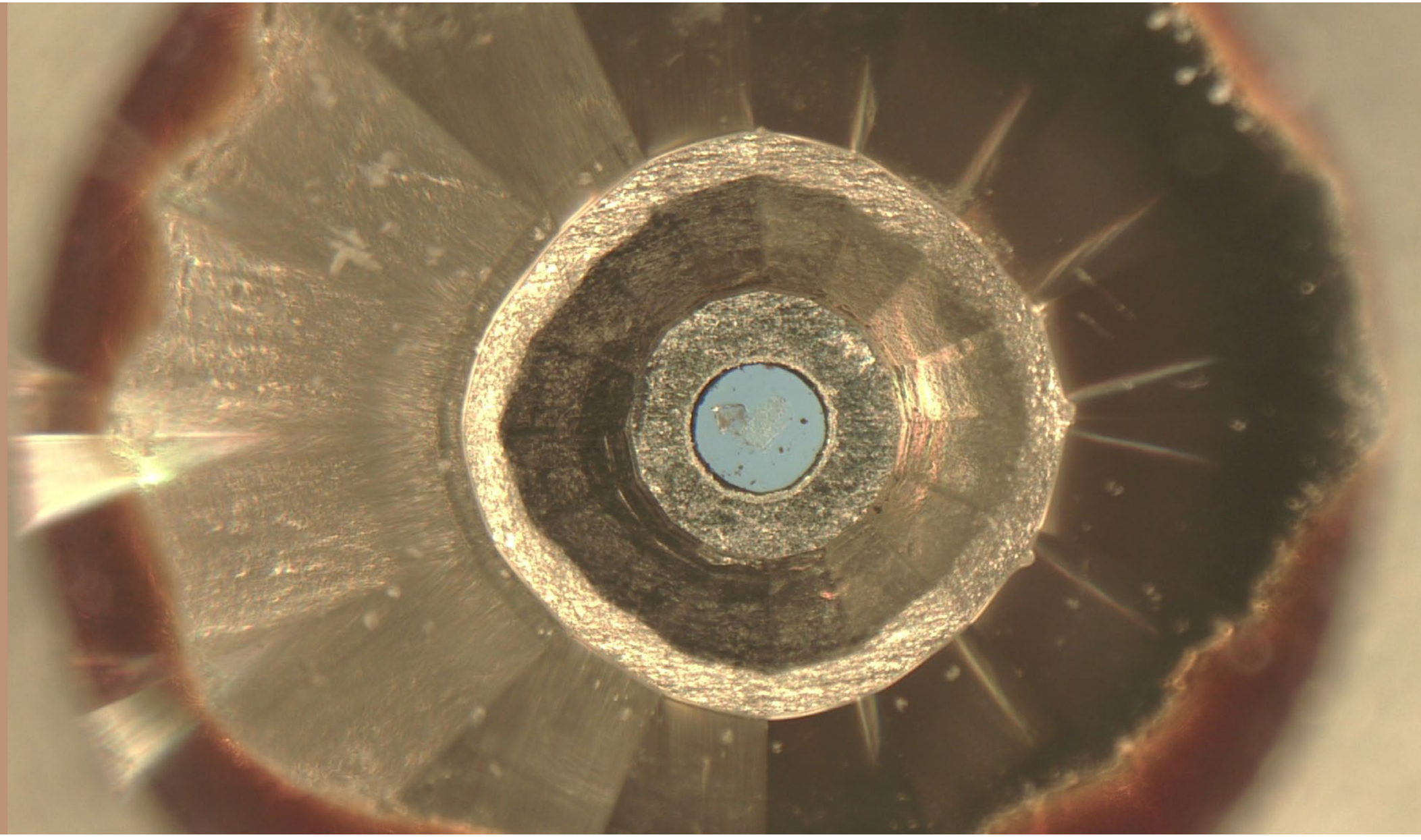
Domestic tenders and calls

	Publication date
Public tender for the allocation of mentorship positions to research programmes in 2020	23 January 2020
Public call for co-financing of the publishing of scholarly monographs in 2020	21 February 2020
Public call for co-financing of the purchase of research equipment – package 19	13 March 2020
Public call for applications to increase the funding of research programmes related to the COVID-19 pandemic	2 June 2020
Invitation for data collection about the involvement of the members of programme groups in projects outside of ARRS-A3 financing	22 June 2020
Public tender for the selection of research projects within the framework of the "Zagotovimo.si hrano za jutri" CRP 2020 targeted research programme for 2020	26 June 2020
Public tender for the selection of research projects within the framework of the "CRP COVID-19" targeted research programme for 2020	10 July 2020
Public call for co-financing of publishing of Slovenian science periodicals in 2021 and 2022	18 September 2020
Public call for co-financing of the purchase of international scientific literature in 2020	9 October 2020
Public call for co-financing of publishing of Slovenian popular science periodicals in 2021 and 2022	9 October 2020
Public call for reimbursement of costs for scientific publications in golden open access (for 2020)	23 October 2020
Public call for the (co)financing of research projects in 2021	11 December 2020
Public tender for the selection of research projects within the framework of the "Zagotovimo.si hrano za jutri" targeted research programme for 2020-II	24 December 2020

International tenders and calls

	Publication date
Public call for co-financing the Slovenian section of joint Flemish–Slovenian projects with The Research Foundation – Flanders (FWO) as the lead agency	17 January 2020
Public call for co-financing the Slovenian section of joint Hungarian–Slovenian projects with NKFIH (National Research, Development and Innovation Office) as the lead agency	17 January 2020
Public call for co-financing scientific research co-operation between the Republic of Slovenia and the People's Republic of China in 2020 and 2022	17 January 2020
Public call for co-financing scientific research co-operation between the Republic of Slovenia and the French Republic in the framework of the PROTEUS programme in 2021 and 2022	24 January 2020
Public call for co-financing the Slovenian section of joint Austrian–Slovenian projects with FWF (FWF Der Wissenschaftsfonds) as the lead agency - CEUS	24 February 2020
Public call for co-financing the Slovenian section of joint Czech–Slovenian projects with GA ČR (Grantová Agentura České Republiky) as the lead agency - CEUS	24 February 2020
Public call for co-financing scientific research co-operation between the Republic of Slovenia and the Republic of India in 2021 - 2023	28 February 2020
Public call for co-financing the Slovenian section of SARS-CoV-2/COVID-19 bilateral or trilateral joint research projects with FWF (Fonds zur Förderung der wissenschaftlichen Forschung) as the lead agency	17 April 2020
Public call for co-financing the Slovenian section of CEUS bilateral or trilateral joint research projects with FWF (Fonds zur Förderung der wissenschaftlichen Forschung) as the lead agency	17 April 2020
Public call for co-financing the Slovenian section of SARS-CoV-2/COVID-19 bilateral or trilateral joint research projects with SNSF (Swiss National Science Foundation, SNSF) as the lead agency	8 May 2020
Public call for (co-)financing activities related to the promotion of Slovenian science abroad and integration of scientific achievements in 2020	22 May 2020
Public call for co-financing scientific research co-operation between the Republic of Slovenia and BiH in 2021 and 2022	19 June 2020
Public call for co-financing scientific research co-operation between the Republic of Slovenia and Japan in 2021 - 2023	19 June 2020
Public call for co-financing of science and research co-operation between the Republic of Slovenia and the French Commissariat for alternative and atomic energy (CEA) in 2021 - 2023	19 June 2020
Public call for co-financing scientific research co-operation between the Republic of Slovenia and the Federal Republic of Germany in 2021 - 2022	19 June 2020
Public call for co-financing of memberships of Slovenian societies and associations of societies in international science associations in 2020	19 June 2020
Public call for co-financing scientific research co-operation between the Republic of Slovenia and Hungary in 2021 - 2022	26 June 2020
Public call for co-financing the Slovenian section of CEUS bilateral or trilateral joint research projects with NCN (Narodowe Centrum Nauki) as the lead agency	18 September 2020
Public call for co-financing of adapted research projects within the complementary scheme for applications to European Research Council (ERC) calls	18 September 2020
Public call for co-financing of Marie Skłodowska-Curie Seal of Excellence research projects	18 September 2020
Public call for postdoctoral research scholarships in Japan for researchers from the Republic of Slovenia in 2021	4 December 2020

EXCELLENT IN SCIENCE
2020



Excellent in science is a project carried out by the ARRS as part of agency's endeavours to promote science.

The project presents a selection of most prominent achievements from the past year.

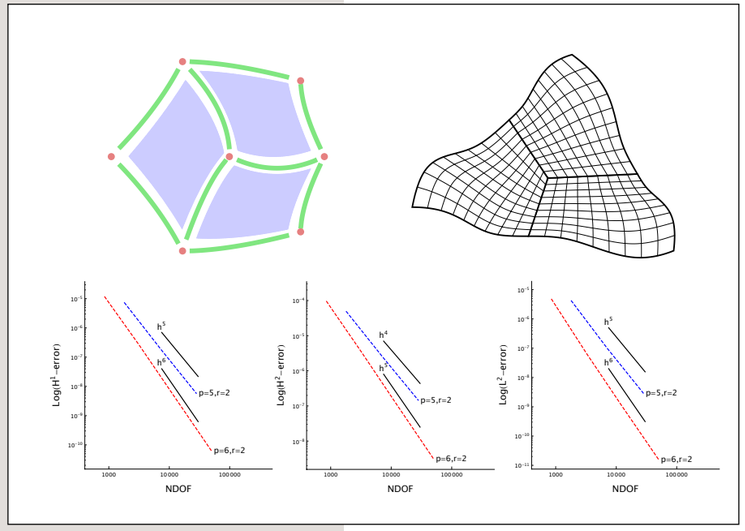
In 2020, some of the selected achievements were presented at **the national event titled ARRS Day 2020: Supporting Excellence** held on 16 December 2020. The selection of achievements was proposed by members of Scientific Research Councils for each scientific discipline and was confirmed by the agency's Scientific Council.

Image on the previous page:
Crystal of a xenon compound in a cell with diamond anvils under high pressure.

Dr. Vito Vitrih

Isogeometric collocation on planar multi-patch domains

Partial differential equations are crucial to the understanding of the world around us. A number of phenomena in the fields of engineering, physics, chemistry, biology, astronomy, economics, etc., can be described with the help of differential equations. Isogeometric analysis is one of the newest approaches for numerical solution of partial differential equations. This approach enables the use of the same approximation space both for the representation of the domain geometry as well as the differential equation solution description for the numerical simulation itself. In addition to the standard Galerkin discretization for solving partial differential equations, the collocation method can also be used. Compared with the Galerkin discretization, all known choices of collocation points have a suboptimal order of convergence, however, computation using the collocation method is more efficient. Thus, a twice continuously differentiable approximation of the solution of the Poisson equation over planar multi-patch domains was constructed with the collocation method in the study. Superconvergent collocation points are obtained for these multi-patch domains, which prove to be better, compared to the known families of collocation points.



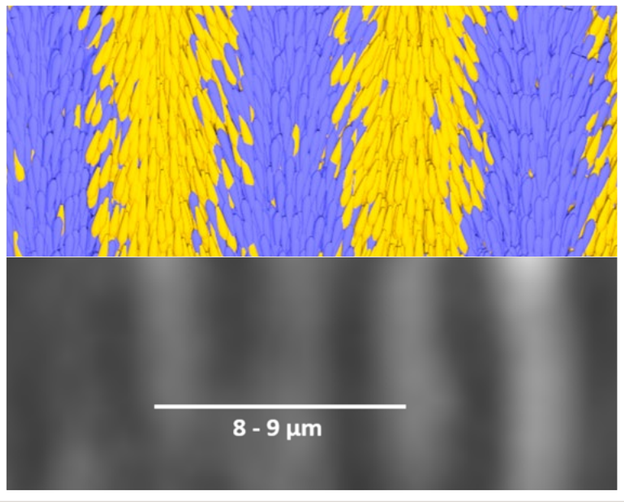
Dr. Vito Vitrih, University of Ljubljana Faculty of Mathematics and Physics (vito.vitrih@upr.si)

Source: KAPL, Mario, VITRIH, Vito. Isogeometric collocation on planar multi-patch domains. Computer methods in applied mechanics and engineering, ISSN 0045-7825, 2020, vol. 360, pp. 1-23.
Hyperlink: https://osebje.famnit.upr.si/~vito.vitrih/papers/Collocation.pdf

Dr. Irena Drevenšek Olenik

Ferroelectric-ferroelastic phase transition in a nematic liquid crystal

The existence of ferroelectricity in liquids has remained for a long time an important basic question in physics. Although there is no fundamental reason opposing ferroelectric or polar order in liquids, it has not been until recently that researchers have been able to prepare the first substances in which it appears. N. Sebastián and co-workers have shown that the recently discovered splay-nematic liquid crystalline phase, which is built of strongly polar wedge-shaped molecules, belongs to this class of materials. Nematic phases are very similar to ordinary liquids, except that they are built of anisotropic molecules, classically rod- or disc-like, which try to align parallel to each other. Although molecules in conventional nematics carry an electric dipole moment, on average, half of the molecules point in one direction and another half in the opposite direction, so that the material does not show any polar or ferroelectric order on the macroscopic scale. However, in the case of a splay deformation of a nematic made of polar wedge-shaped molecules, a greater number of molecules turn in one direction than in the other, resulting in the formation of a macroscopic electrical polarization. This phenomenon is called flexoelectric effect. In the study reported in the prestige journal Physical Review Letters, the above-mentioned researchers found that the phase transition from the ordinary nematic to the splay-nematic phase is a ferroelectric phase transition in which the flexoelectric coupling causes simultaneous occurrence of electrical polarization and instability towards splay deformation. The latter causes the formation of a spatially modulated structure. By means of the second harmonic generation microscopy, the authors measured the period of this spatial modulation to be a few micrometers. This work has received recognition from the scientific community, as the editors of the Physical Review Letters distincted it in the category "Editors' Suggestion". The journal of the American Physicists Association "Physics Today" also reported about this work in an article published in April 2020.



The described liquid crystalline phase represents the first-ever discovered example of a ferroelectric nematic fluid made of small molecules. Due to its unique nonlinear optical and electrical properties, such a phase has a great potential for technological developments, such as electric field tunable nonlinear photonic devices.

Dr. Irena Drevenšek Olenik, "Jožef Stefan" Institute (irena.drevensek@ijs.si)

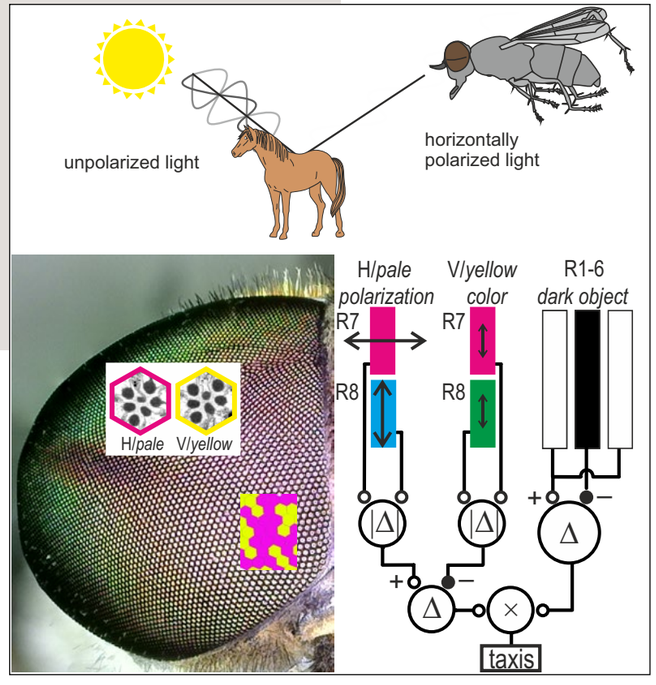
Source: N. Sebastián, L. Cmok, R. J. Mandle, M. R. de la Fuente, I. Drevenšek Olenik, M. Čopič, and A. Mertelj, Phys. Rev. Lett., 124, 037801 (2020). doi: 10.1103/PhysRevLett.124.037801
Hyperlink: https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.124.037801

Dr. Gregor Belušič

Mechanism of object detection with polarization vision

Insect compound eyes are a random mosaic of two or more types of optical units, the facets or ommatidia. Some facets contain light-sensitive cells that are sensitive to polarized light, but their functional integration into the visual system has been poorly understood. Female horseflies are an excellent research model as they seek their prey on the basis of polarized reflections from animal fur. Therefore, researchers from the Biotechnical Faculty studied vision in horseflies with the combination of physiological, anatomical, photometrical and behavioural methods. They have discovered that horsefly retina contains two types of facets which separately analyse colour and polarization of light. Functional segregation of facets goes beyond colour vision and is very likely to be a common feature among insects. The study has explained why the horseflies are attracted to shiny, and also to blue objects.

Understanding of the structure and function of retinal mosaic is an important contribution to developmental neuroscience. Understanding of the mechanism will help to control the biting flies which carry deadly diseases. Horsefly eyes are also a blueprint for a miniature hybrid imaging sensor, which will inspire the design of advanced machine vision systems, including those in autonomous vehicles.



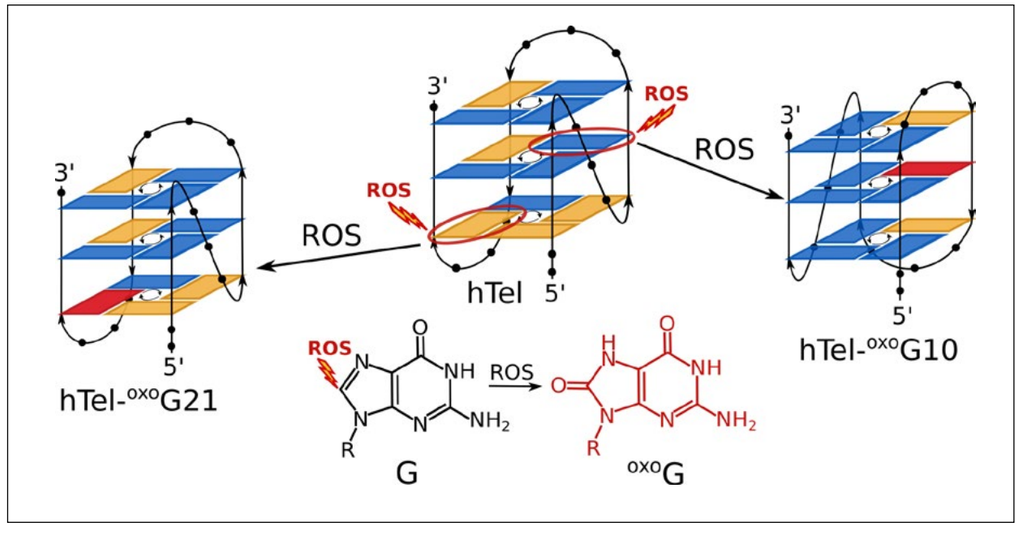
Dr. Gregor Belušič, University of Ljubljana, Biotechnical Faculty (gregor.belusic@bf.uni-lj.si)

Source: Meglič, A., Ilić, M., Pirih, P., Škorjanc, A., Wehling, M. F., Kreft, M., & Belušič, G. (2019). Horsefly object-directed polarotaxis is mediated by a stochastically distributed ommatidial subtype in the ventral retina. Proceedings of the National Academy of Sciences, 116(43), 21843-21853.
Hyperlink: https://www.pnas.org/content/116/43/21843

Dr. Peter Podbevšek

Impact of Oxidative Lesions on the Human Telomeric G-Quadruplex

Oxidative damage affects the stability and structure of DNA. One of the four building blocks, guanine, is particularly susceptible to oxidation. We studied guanine-rich telomeric regions (hTel), which form unusual four-stranded structures, G-quadruplexes, and protect chromosome ends from erosion. Guanine sites were systematically analysed by substitutions with the oxidized derivative - 8-oxo-7,8-dihydrogvanin (oxoG). Due to a specific way of hydrogen bond formation, a loss of G-quadruplex structure was observed in most constructs containing oxidative damage. Nevertheless, we found that some positions in the hTel sequence tolerate the presence of oxoG. Upon substituting with oxoG, the system responds by maintaining or switching to a topology where oxoG is in a specific glycosidic conformation. Most importantly, these G-quadruplex structures are still stable at physiological temperatures and should be considered detrimental to higher order telomere structures. Any abnormalities in the functioning of telomeres are associated with cancer and aging processes.



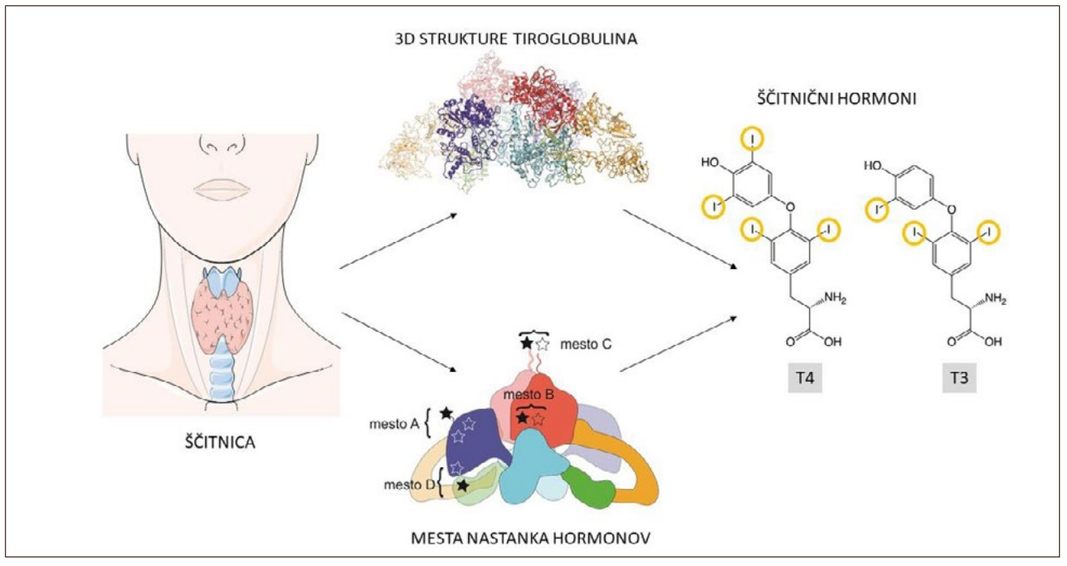
Dr. Peter Podbevšek, National Institute of Chemistry (peter.podbevsek@ki.si)

Vir: S. Bielskutė, J. Plavec, P. Podbevšek, Impact of Oxidative Lesions on the Human Telomeric G-Quadruplex. J. Am. Chem. Soc., 2019, 141, 2594−2603.
Hiperpovezava: https://pubs.acs.org/doi/10.1021/jacs.8b12748

Dr. Dušan Turk

The structure of human thyroglobulin

Thyroglobulin (TG) is the protein precursor of thyroid hormones, which are essential for growth, development and control of metabolism in vertebrates. Hormone synthesis from TG occurs in the thyroid gland via the iodination and coupling of pairs of tyrosines, and is completed by TG proteolysis. Tyrosine proximity within TG is thought to enable the coupling reaction but hormonogenic tyrosines have not been clearly identified, and the lack of a three-dimensional structure for TG has prevented understanding of the mechanism. Here, we present the structure of full-length human thyroglobulin at a resolution of approximately 3.5 Å, determined by cryo-electron microscopy. We identified all of the hormonogenic tyrosine pairs in the structure, and verified them using site-directed mutagenesis and in vitro hormone-production assays. Our analysis revealed that the proximity, flexibility and solvent exposure of the tyrosines are the key characteristics of hormonogenic sites. Our study provides a framework to further understand the production and regulation of thyroid hormones.
Thyroglobulin, a precursor of T3 and T4 hormones, belongs to the core of endocrinology. The structure helped unravel the mechanism of hormone generation and established the basis for further studies of thyroid-related diseases, which affect 5% of the population.



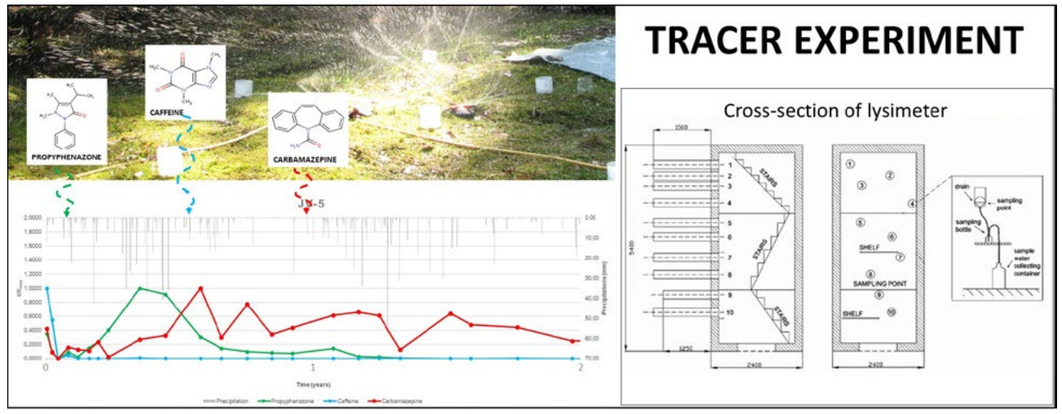
Dr. Dušan Turk, "Jožef Stefan" Institute (dusan.turk@ijs.si)

Source: COSCIA, Francesca, TALER-VERČIČ, Ajda, CHANG, Veronica T., SINN, Ludwig, O'REILLY, Francis J., IZORÉ, Thierry, RENKO, Miha, BERGER, Imre, RAPPSILBER, Juri, TURK, Dušan, LÖWE, Jan. The structure of human thyroglobulin. Nature: The International Weekly Journal of Science. [Print ed.]. Feb. 2020, vol. 578, pp. 627-630, illustr. ISSN 0028-0836.
Hyperlink: https://www.nature.com/articles/s41586-020-1995-4

Dr. Anja Koroša

Estimating the transport parameters of propyphenazone, caffeine and carbamazepine by means of a tracer experiment in a coarse-gravel unsaturated zone

The article presents the determination of mass transport in the unsaturated zone of coarse-gravel aquifer and its hydraulic properties as well as the study of transport processes of three pharmaceuticals, propyphenazone, caffeine and carbamazepine by means of a tracer experiment in a lysimeter. Although there is no numerical tool to model the known hydraulic properties of coarse-gravel sediments of the unsaturated zone, the authors were able to determine the parameters of the unsaturated zone by inverse numerical modelling using the van Genuchten-Mualem model. Based on the obtained data of the unsaturated zone, the parameters of sorption (Kd) and degradation (, T1/2) of selected pharmaceutical were determined. Caffeine has the lowest sorption capacity (mean Kd = 0.027 Lkg-1) but decays rapidly (maximum T1/2 = 69.31 days). Sorption coefficient of propyphenazone is higher (Kd = 0.07 Lkg-1) and its degradation is slower compared to caffeine (highest T1/2 = 92.42 days). The parameters for carbamazepine could not be determined using an advection dispersion equation, which suggests complex transport mechanisms for the compound. The article was published in March 2020 in Water Research, which is the most prestigious journal in the field of water research, and thus ranks among the outstanding achievements (A ''). Research results represent a great contribution to the development of science in the field of knowledge related to the transport processes rules as well as sorption and degradation of pharmaceuticals in intergranular gravel aquifers. This is one of the first experiments where transport parameters were calculated on a real-life case. No similar experiment in gravel aquifers in nature has been known thus far. Most of the results that have been published to date are based on laboratory experiments. Finally, the results also contribute to a safer use of drinking water and can serve as a basis for assessing the impact of pollutants on drinking water users.



Dr. Anja Koroša, Geological Survey of Slovenia (anja.korosa@GEO-ZS.SI)

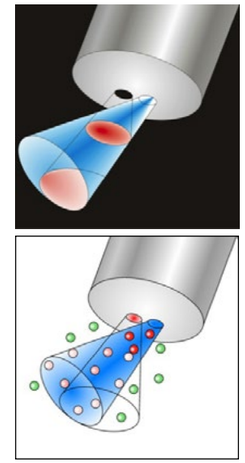
Source: KOROŠA, Anja, BRENČIČ, Mihael, MALI, Nina. Estimating the transport parameters of propyphenazone, caffeine and carbamazepine by means of a tracer experiment in a coarse-gravel unsaturated zone. Water Research, 175, 1-12. DOI: 10.1016/j.watres.2020.115680. [COBISS.SI-ID 3026005]
Hyperlink: https://pubmed.ncbi.nlm.nih.gov/32217381/

Dr. Bojan Sedmak

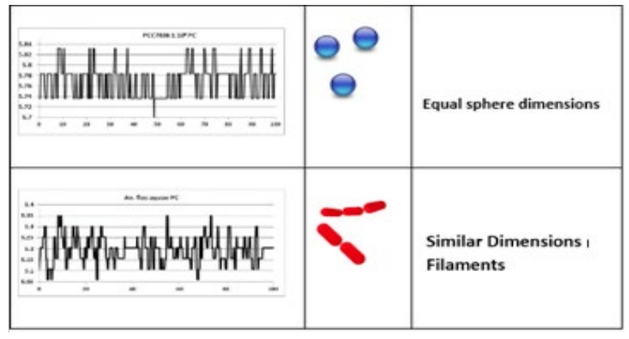
Method and system for simultaneous detection of micro-particle concentration in suspension and their morphological and physiological traits

The described method is applied for the detection and monitoring of various communities and aggregations of micro-particles of different shapes and sizes, such as microorganisms and organic and inorganic particles in suspension, which are able to absorb and/or emit radiation of certain wavelengths. Importantly, this non-invasive method allows for the preservation of characteristics of individual elements of the entire population of microparticles in suspension, either in liquid or gaseous environments. This is achieved by creating a steady unidirectional flow of low turbulence, which allows the particles to transition into the detection areas as average populations.
A remarkable advantage of the method is the ability to non-invasively determine the number, structure, shape and composition of microparticles, their masses and communities, and some of their physiological properties in real time. The method uses pulsed induced high-frequency illumination to track changes in individual microparticles without interfering with the structure of the community.
The principle was tested in the laboratory and in the field with an autonomous (solar powered) portable device on solar-powered robotic vessels that detect the concentration of various phytoplankton organisms in water bodies and separated them according to behaviour, form, and origin, which enables the evaluation of biological water quality.
This innovative method can also be applied for controlling the homogeneity of inorganic materials such as solid (PM) particles in air quality measurements. The method is compatible with mobile data transfer. 5G data transfer technology will make it possible to obtain even more accurate information about the behaviour of microparticle communities in the environment.

Level of technological development: developed demostratory prototype - technology transfer offer



The figure shows the detection of particles in an inhomogeneous excitation space (left). As they pass through the sensor detection area, the particles respond differently. Microparticles in the optimal position trigger the strongest response (red).



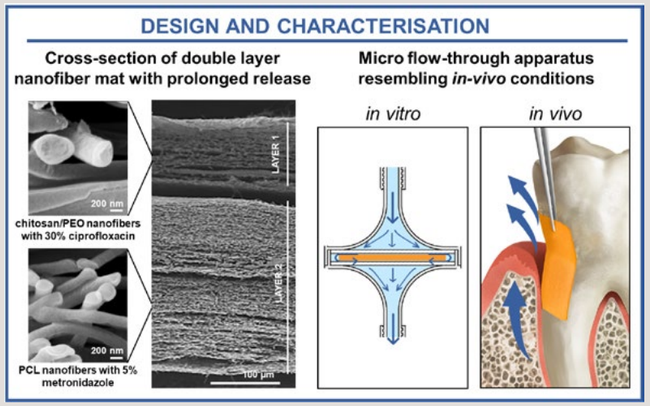
Dr. Bojan Sedmak, National Institute of Biology (bsedmak.bs@gmail.com)

Source: SEDMAK, Bojan, LAKOVIČ, Gorazd, LEŠTAN, Domen, MEGLIČ, Andrej, GERL, Marko. Method and system for simultaneous detection of micro-particle concentration in suspension and their morphological and physiological traits = Verfahren und System zur Gleichzeitigen Detektion von Mikropartikelkonzentration in Suspension und Deren Morphologischen und Physiologischen Merkmale = Procédé et système pour la détection simultanée de la concentration de microparticules en suspension et de leurs caractéristiques morphologiques et physiologiques : European patent specification EP 3 073 246 B1, 2019-08-14. München: European Patent Office, 2019. 14 f., patent family: EP3073246 (A1), 2016-09-28; 15161547.3
Hyperlink: https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2016156281

Dr. Julijana Kristl

Potential of nanofibers with antimicrobials for local treatment of periodontal disease

Periodontal disease is a widespread chronic condition. As the efficacies of current therapies are limited, the development of new treatment approaches and drug delivery systems is crucial. This important research achievement presents the development of a nanodelivery system for local application of antimicrobials, as well as an in-vitro micro flow-through apparatus that simulates local in-vivo conditions in the periodontal pocket (i.e., small resting volume, low gingival crevicular fluid flow rate), and enables the evaluation of drug release. Ciprofloxacin and metronidazole have shown additive action against a broad spectrum of periodontopathogens, and so we incorporated them into an innovative double layer nanofiber mat. The precisely designed composition provides prolonged release of both of these antimicrobials in vitro.



The use of the developed nanofiber mat provides action against Escherichia coli and Aggregatibacter actinomycetemcomitans. The drug concentrations released from the nanofiber mats were above the minimal inhibitory concentrations of ciprofloxacin and metronidazole against the periodontal pathogens for up to 7 days, which is valuable information for prediction of the efficacy of this nanodelivery system in vivo.

The local application of antimicrobial-loaded nanofiber mat is expected to prolong the retention of the nanomedicine at the target site and improve drug penetration into the biofilm. Thus, systemic exposure to antibiotics and the potential for development of resistant bacterial strains can both be reduced compared to oral drug administration. This research represents the starting point for the development of a clinically applicable medicine, which is expected to be not only more patient-friendly and therapeutically active, but also cost effective.

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Source: Zupančič, Špela, Casula, Luca, Rijavec, Tomaž, Lapanje, Aleš, Luštrik, Matevž, Fadda, Anne Maria, Kocbek, Petra, Kristl, Julijana. Sustained release of antimicrobials from double-layer nanofiber mats for local treatment of periodontal disease, evaluated using a new micro flow-through apparatus. Journal of controlled release. Dec. 2019, vol. 316, pp. 223-235. DOI: 10.1016/j.jconrel.2019.10.008. [COBISS.SI-ID 4838257]
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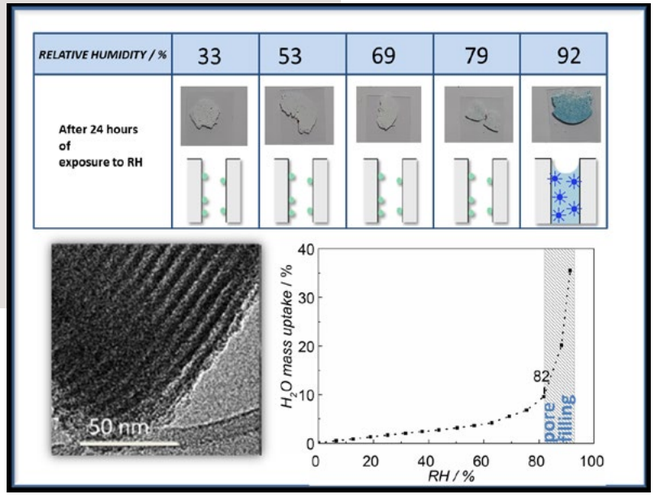
Dr. Erika Švara Fabjan

Development of indicators based on porous materials

Indoor air quality has a major influence on the wellbeing of residents. Relative humidity as one parameter of the indoor environment impacts human health as well as the durability of materials. High relative humidity is associated with a risk of mould growth, which is harmful to humans and destructive to materials. We presented the development of a novel relative humidity indicator based on a selectively functionalised mesoporous SiO2, which changes colour in a narrow, most critical range of relative humidity and could be used as an early warning of elevated humidity. The basis of the indicator is a well-defined periodic structure of SiO2 with pore channel diameters between 2 and 10 nm. After exposure to an environment with relative humidity above a certain limit value, the capillary pore channels are filled with condensed water, followed by dye dissolution and colour change. Selective functionalisation (covalent bonding of methyl groups to the external surface only) is critical for a colour change in a narrow range of relative humidity. Slovenian industry has already shown interest in the development of such and similar indicators.



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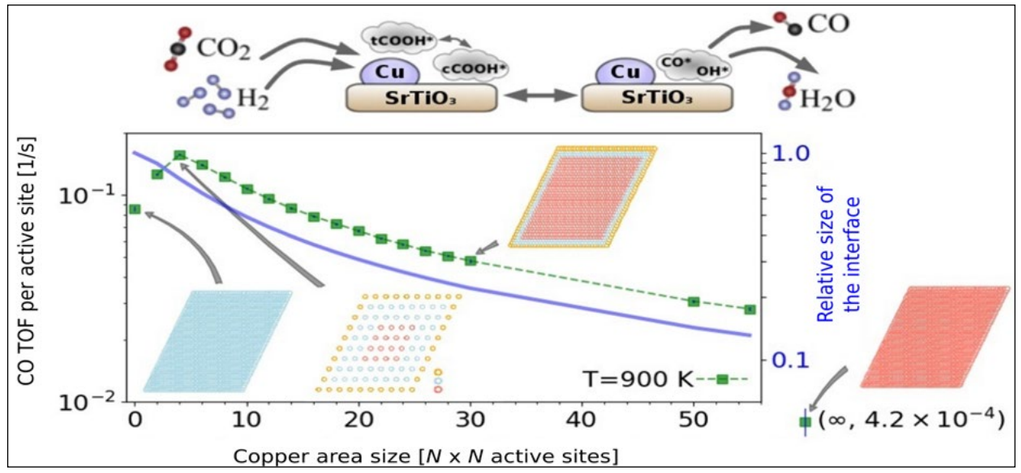
Source: ŠVARA FABJAN, Erika, NADRAH, Peter, AJDOVEC, Anja, TOMŠIČ, Matija, DRAŽIĆ, Goran, MAZAJ, Matjaž, ZABUKOVEC LOGAR, Nataša, SEVER ŠKAPIN, Andrijana. Colorimetric cutoff indication of relative humidity based on selectively functionalized mesoporous silica. Sensors and actuators. B, Chemical, ISSN 0925-4005, 2020, pp. 1-38. doi: 10.1016/j.snb.2020.128138. kategorija: 1Al (Z, A'', A', A1/2). IF(2018)=6,395.
Hyperlink: https://www.sciencedirect.com/science/article/pii/S0925400520304883

Dr. Matej Huš

How size matters: electronic, cooperative, and geometric effect in perovskite-supported copper catalysts for CO2 reduction

The production of most industrially important chemicals and compounds requires the presence of catalysts. In many cases, supported multi-phase catalysts are used as they perform better than single phases. Geometries, arrangements and sizes of individual structural motifs on the catalyst surface are also important. Reverse water-gas shift reaction (RWGS) is used to produce CO and water from CO2 and hydrogen, using catalysts made of copper and perovskite materials. We used multiscale modelling at the atomic (DFT) and meso (kMC) scale to simulate the RWGS mechanism on three surfaces: pure copper (active sites), strontium titanate in a perovskite structure (support), and contact (interfacial surface). Using kinetic simulations, we showed that the fastest reaction occurs on the interfacial surface. When including the two other surfaces, the reaction is accelerated even more, demonstrating that the advantages of a bifunctional catalysts go beyond the formation of the intermediate phase and include active participation of all three phases. Further simulations showed that the reaction rate also depends on the size of the copper islands. The contribution to catalysis was broken down into the geometric, electronic, and cooperative effect. Our simulations confirm and explain the experimentally well-known effect of the shape and size of catalyst surfaces on their activity.



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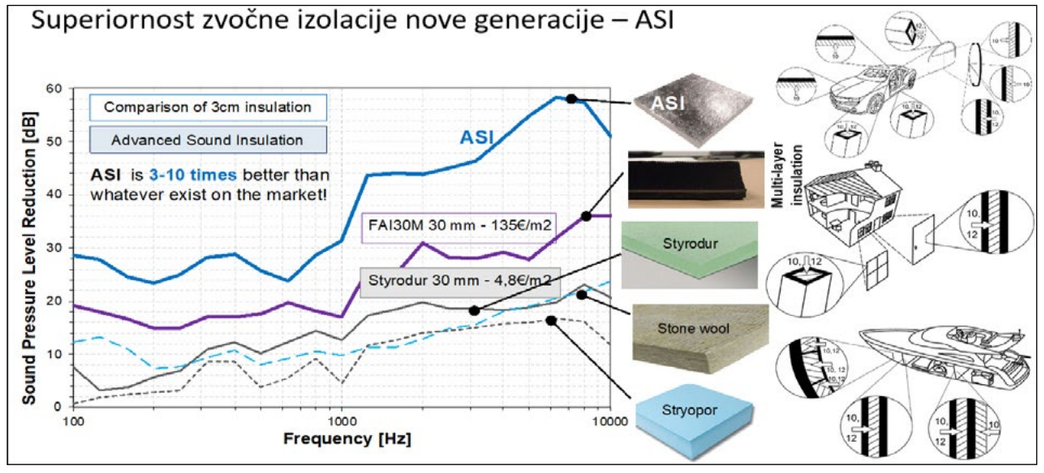
Source: KOPAČ, Drejc, LIKOZAR, Blaž, HUŠ, Matej. How Size Matters: Electronic, Cooperative and Geometric Effect in Perovskite-supported Copper Catalysts for CO2 Reduction, ACS Catalysis, 2020, doi: 10.1021/acscatal.9b05303.
Hyperlink: https://pubs.acs.org/doi/10.1021/acscatal.9b05303

Dr. Anatolij Nikonov

Sound insulation elements based on granular materials

The technological breakthrough is based on the scientific realization that the formation of a "force-network" – a set of pairs of forces (3NZ) – is the most effective dissipative mechanism that exists in nature. The invention relates to the process of forming the optimal size of a network of forces created by complex interactions of solid particles in a granular system. Accordingly, the sound insulation element consists of granular particles and a porous support structure that defines the shape of the insulation. It was found that the amount of dissipated energy is proportional to the size of the force network (number of pairs of forces), which can be described by the "flow index" of granular materials measured with our newly developed measuring system called "GFA analyzer". The largest network of forces is obtained in the case of a multimodal granular particles size distribution. The latter can be predicted by the Knauss-Emri model, which was originally developed for the modelling of nonlinear time-dependent behaviour of polymeric materials. It was surprising to find that the behaviour of granular materials on the micro-macro scale and the behaviour of polymers on the molecular scale can be described by the very same mathematical model if the mechanical spectrum belonging to the selected molar mass distribution is replaced by the normalized granular particle size distribution.



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Source: EMRI, Igor, BERNSTORFF, Bernd Steffen von, OBLAK, Pavel, NIKONOV, Anatolij. Sound insulating element: European patent application EP 3 570 274 A1, 2019-11-20. Munich: European Patent Office, 2019. 38 pp.
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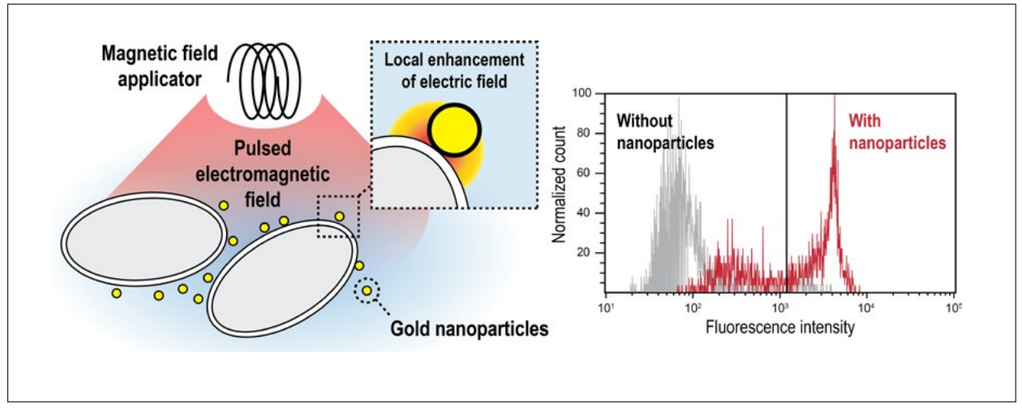
Dr. Damijan Miklavčič

Contactless electroporation induced by high intensity pulsed electromagnetic fields via distributed nanoelectrodes

Pulsed electromagnetic fields increase cell membrane permeability to the molecules which otherwise have poor or no transmembrane transport mechanisms. Compared to the conventional electroporation, which often uses invasive electrodes to establish an electric field in the tissue, the pulsed electromagnetic fields represent a promising alternative delivery method by making the procedures involved in electroporation-based technologies and treatments much safer and easier to implement.

However, the biggest limitation of the pulsed electromagnetic fields is their lower efficiency compared to the conventional electroporation with electrodes. In our study, we demonstrated that by adding highly conductive gold nanoparticles, we increase cell permeabilization by 80 %, with a minimal impact on cell survival. Our findings open new possibilities for combining naked or functionalized gold nanoparticles with pulsed electromagnetic field for non-invasive and controlled drug and gene delivery into cells.



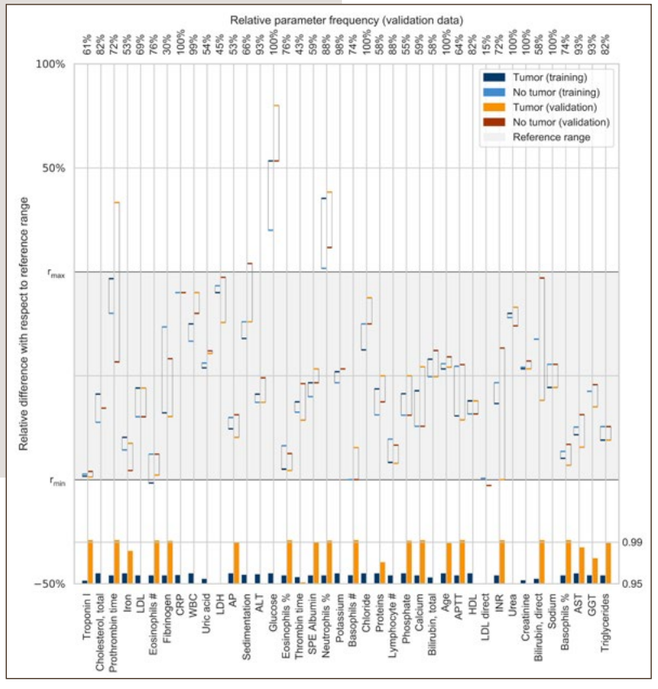
Dr. Damijan Miklavčič, University of Ljubljana, Faculty of Electrical Engineering (damijan.miklavcic@fe.uni-lj.si)

Source: Miklavčič D, Novickij V, Kranjc M, Polajžer T, Haberl Meglič S, Batista Napotnik T, Romih R, Lisjak D. Contactless electroporation induced by high intensity pulsed electromagnetic fields via distributed nanoelectrodes. Bioelectrochemistry 132:107440, 2020.
Hyperlink: https://pubmed.ncbi.nlm.nih.gov/31869699/

Dr. Matjaž Kukar

Diagnosing brain tumours by routine blood tests using machine learning

The diagnosis of brain tumours is very difficult as tumours are rare and often present with nonspecific clinical symptoms. Although brain imaging remains the basic diagnostic tool, additional and cost-effective diagnostic tools are very useful.
The purpose of the study was to evaluate the diagnostic accuracy of a machine learning model that uses routine blood tests to diagnose brain tumours. The study was performed at the Division of Neurology, University Medical Centre Ljubljana. We have built the model using the extreme gradient boosting machine learning method on data obtained from 15,176 patients over a 10-year period. The operating point of maximum performance was determined by cross-validation and ROC analysis. The obtained diagnostic model and operation were verified on an independent validation set of 68 patients with brain tumours and 215 control patients who presented consecutively at the neurological emergency service over a three-month period. Only patients with head imaging and routine blood test data were included in the sample. The reference standard was the final diagnosis of each patient, based primarily on imaging examinations. The sensitivity and specificity in the validation group were 96% and 74%, respectively. The results of the study demonstrate the feasibility of diagnosing a brain tumour from routine blood tests using machine learning. The reported diagnostic accuracy is comparable to that of imaging examinations and demonstrates the utility of information that can be revealed from routine blood tests.



The figure shows the medians of blood test parameters for the two datasets (training, validation) and diagnoses (tumour, no tumour). Each blood test parameter has been normalised to its specific reference range (rmin and rmax). The differences in datasets with regard to the diagnosis (tumour vs. no tumour) are clear in many cases and statistically significant.

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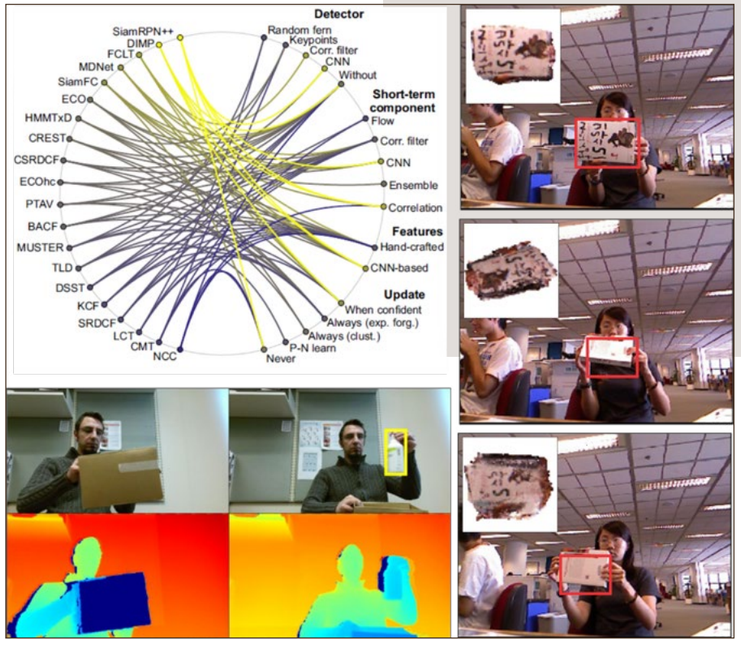
Source: Podnar, S., Kukar, M., Gunčar, G. et al. Diagnosing brain tumours by routine blood tests using machine learning. Sci Rep 9, 14481 (2019).
Hyperlink: https://www.nature.com/articles/s41598-019-51147-3

Dr. Matej Kristan

Performance evaluation methodology for long-term single-object tracking

Long-term visual object tracking is one of the central computer vision problems with a great application potential in autonomous robotic vehicles navigation systems, video editing, entertainment industries, 3D reconstruction and augmented reality. The problem is particularly complex, as the object is annotated only in the first frame, may then leave the camera field of view and re-enter it at a later point in time. The tracking algorithm must therefore adapt to the object appearance and cope with disappearance and re-appearance. We proposed a new methodology and currently the most challenging datasets, which have become part of the standard performance evaluation protocols in long-term tracking. Based on the analysis, we developed a new tracker capable of simultaneous object localization and 3D reconstruction. This is the first methodology for tracking and reconstruction of non-rigid objects, which allows the object to leave the camera field of view for potentially long periods of time.



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Alan, Lukežič, Luka Čehovin Zajc, Tomáš Vojir, Jiří Matas, Matej Kristan. Performance evaluation methodology for long-term single-object tracking. IEEE transactions on cybernetics, 2020.
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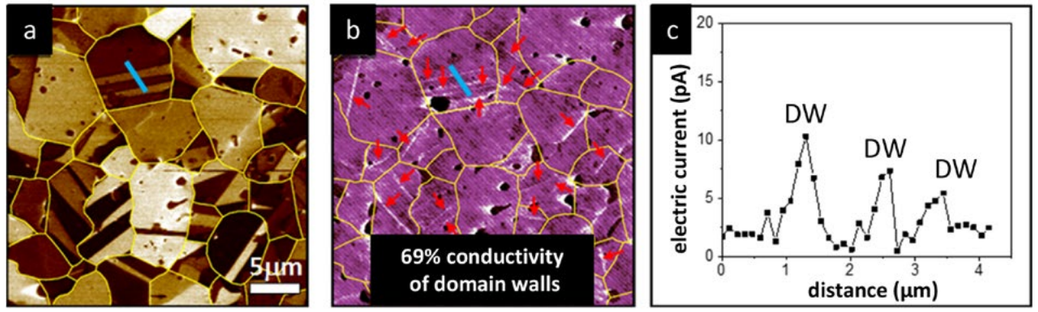
Dr. Hana Uršič Nemevšek

Innovative approaches for control of multiferroic functional responses

Caloric materials are intensively studied for the use in new environmental-friendly solid-state cooling systems. As part of the J2-9253 Multicaloric cooling project, the Electronic Ceramics Department research group is developing single-phase multicaloric materials that combine electrocaloric and magnetocaloric effects. The materials are based on lead iron niobate and bismuth ferrite, and exhibit extremely high temperature differences of 2 to 2.5 K for each individual effect. To achieve high caloric effects, the materials should exhibit low electrical conductivity. Researchers from the Electronic Ceramics, Solid State Physics, and Nanostructured Materials departments at Jožef Stefan Institute, researchers from Institute of Chemistry in Ljubljana and colleagues from America and Poland, have developed innovative approaches to control electrical conductivity in the multiferroics. These approaches are based on the control of chemical compositions and heat treatments during material processing. Research achievements, which were mainly carried out in Slovenia, are published in high-impact international journals, including the Nature Communications.

The figure shows local properties of bismuth ferrite ceramics determined by an atomic force microscope: (a) piezoelectric response, (b) electrical conductivity of domain walls (DW), and (c) line profile of electrical conductivity measured in the area marked by the blue line in Figures (a) and (b). The red arrows in Figure (b) mark conductive DWs [after Benčan et al., Nat. Commun. 2020].



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Sources:

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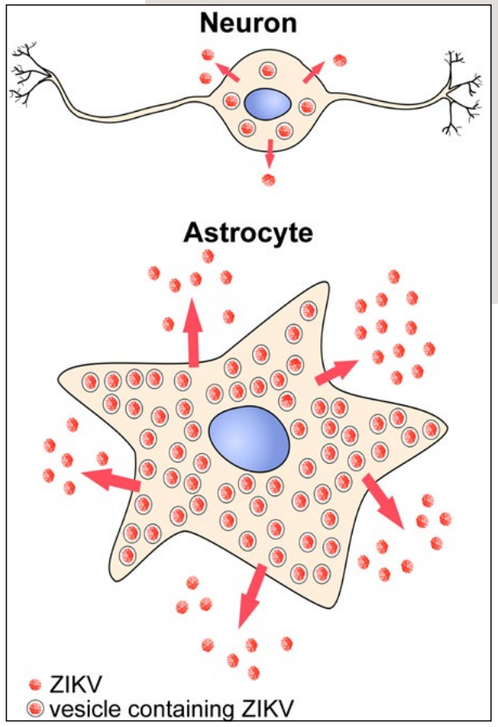
Dr. Jernej Jorgačevski

Astrocytes play a pivotal role in virus infections of the central nervous system

Malformations of the foetal central nervous system (CNS), known as microcephaly, have recently been linked to Zika virus (ZIKV) infection. ZIKV can infect various cell types in the CNS, including astrocytes, which have many critical roles in the functioning of neurons and thus may contribute to further expansion of microcephaly. In this study, we have shown that astrocytes are one of the most important cells in ZIKV infection. Compared to neurons, astrocytes are more susceptible to ZIKV infection, release more progeny virus and tolerate higher virus loads. Moreover, we have identified differences among different ZIKV strains at several steps of the viral cycle, such as different infection rates, virus production and trafficking of endocytotic ZIKV-laden vesicles, which may contribute to specific cell responses. Our next objective is to identify substances that would limit the entry of viruses into cells and/or virus exit. Our ensuing study has revealed that ketamine is a promising candidate, as it modulates exo- and endocytosis by affecting cholesterol domains in the plasmalemma of astrocytes.



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Source: JORGAČEVSKI, Jernej, KORVA, Miša, POTOKAR, Maja, LISJAK, Marjeta, AVŠIČ-ŽUPANC, Tatjana, ZOREC, Robert. ZIKV strains differentially affect survival of human fetal astrocytes versus neurons and traffic of ZIKV-laden endocytotic compartments. Scientific reports. May 2019, vol. 9, iss. 1, pp. 1-14, illustr. ISSN 2045-2322.
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Dr. Damjan Osredkar

Relationship between cardiorespiratory phase coherence during hypoxia and genetic polymorphism in humans

Periodic breathing (PB) occurs in most humans at high altitudes and is characterised by low-frequency periodic alternation between hyperventilation and apnoea. In hypoxia-induced PB the dynamics and coherence between heart rate and respiration and their relationship to underlying genetic factors is still poorly understood. The objective of this study was to investigate, through novel usage of time-frequency analysis methods, the dynamics of hypoxia-induced PB in healthy individuals genotyped for a selection of antioxidative and neurodevelopmental genes. Breathing, ECG and microvascular blood flow were simultaneously monitored for 30 min in 22 healthy males. The same measurements were repeated under normoxic and hypoxic (normobaric (NH) and hypobaric (HH)) conditions, at real and simulated altitudes of up to 3800 m. Subjects were genotyped for common functional polymorphisms in antioxidative and neurodevelopmental genes. During hypoxia, PB resulted in increased cardiorespiratory coherence at the PB frequency. This coherence was significantly higher in subjects with NOTCH4 polymorphism, and significantly lower in those with CAT polymorphism (HH only). The results provide further evidence for a genetic predisposition to PB and may partly explain the heterogeneity in the hypoxic response.

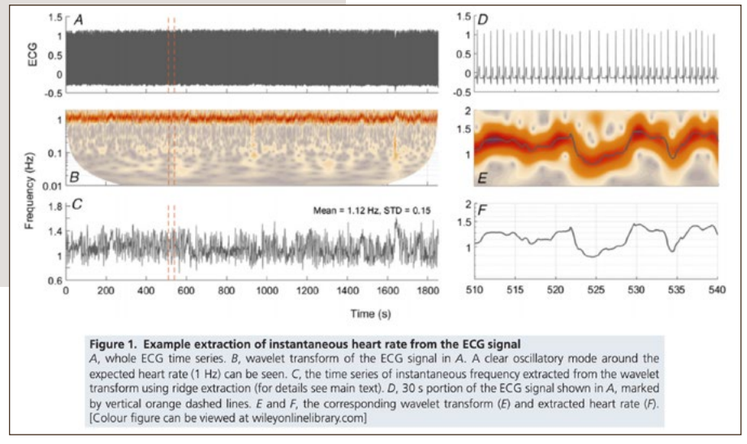

Figure 1. Example extraction of instantaneous heart rate from the ECG signal
A, whole ECG time series. *B*, wavelet transform of the ECG signal in *A*. A clear oscillatory mode around the expected heart rate (1 Hz) can be seen. *C*, the time series of instantaneous frequency extracted from the wavelet transform using ridge extraction (for details see main text). *D*, 30 s portion of the ECG signal shown in *A*, marked by vertical orange dashed lines. *E* and *F*, the corresponding wavelet transform (*E*) and extracted heart rate (*F*). [Colour figure can be viewed at wileyonlinelibrary.com]

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Source: LANCASTER, Gemma, DEBEVEC, Tadej, MILLET, Grégoire P., POUSSEL, Mathias, WILLIS, Sarah, MRAMOR, Minca, GORIČAR, Katja, OSREDKAR, Damjan, DOLŽAN, Vita, STEFANOVSKA, Aneta. Relationship between cardiorespiratory phase coherence during hypoxia and genetic polymorphism in humans. The journal of physiology. [Online ed.]. 2020, pp. 1-34, illustr. ISSN 1469-7793.
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Dr. Simon Podnar

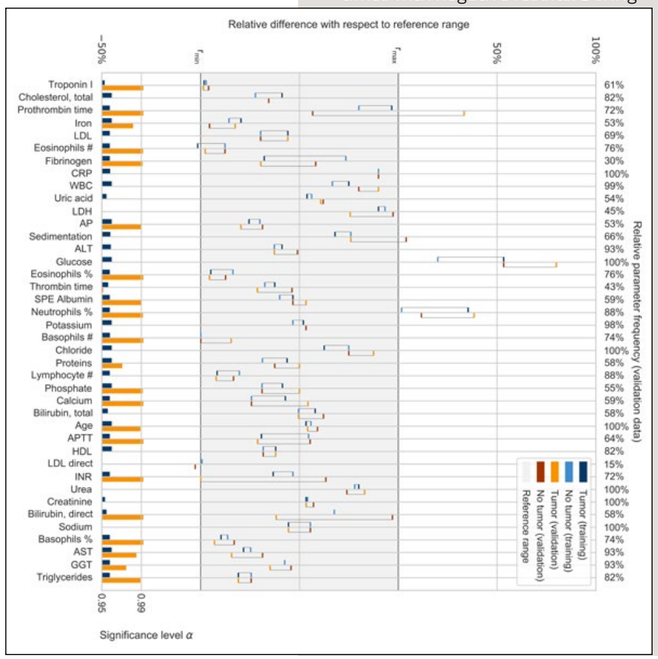
Diagnosing brain tumours by routine blood tests using machine learning

Brain tumours are serious, but fortunately rare diseases of the central nervous system. Because patients with brain tumours often present with non-specific complaints, such as headache and psychological changes, tumour detection is challenging. Diagnosis of brain tumours is usually based on clinical features and imaging studies. Due to the rarity and severity of these conditions, expensive diagnostic work-up is usually performed, most of the times with negative results. During imaging studies, patients are often exposed to radiation. Diagnostic accuracy of the imaging studies is not always optimal.

During growth, brain tumours secrete into the surrounding tissues a number of substances, and body also reacts to tumour growth. Both of these processes change the composition of blood and other body fluids. Our machine learning algorithm "learned" to recognise blood samples of patients with brain tumours on the blood samples of 15,176 patients examined at the Division of Neurology, University Medical Centre Ljubljana. Brain tumour was found in 701 of the patients. We validated the diagnostic accuracy of the approach in 68 consecutive patients having brain tumour and 215 controls. We found that the sensitivity of the method is 96 %, and specificity reached 74 %. Sensitivity of our algorithm to detect brain tumours was similar to the sensitivity of imaging studies.

We have proven that brain tumour diagnosis is possible using the results of routine blood tests and applying a machine learning algorithm. Even more significant is the confirmation that the machine learning algorithm can detect medical conditions which are not detectable by physicians using only routine blood tests. Authors believe that these study findings open a completely new approach to diagnosing brain tumours.

Median values of main 40 parameters of routine blood tests in patients with brain tumours and patients with other neurological disorders. On the left, specificity (0.95 in 0.99) of differences in blood parameters between both groups of patients are shown.



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Source: PODNAR, Simon, KUKAR, Matjaž, GUNČAR, Gregor, NOTAR, Mateja, GOŠNJAK, Nina, NOTAR, Marko. Diagnosing brain tumours by routine blood tests using machine learning. Scientific reports. 2019, vol. 9, pp. 1-7, illustr. ISSN 2045-2322.
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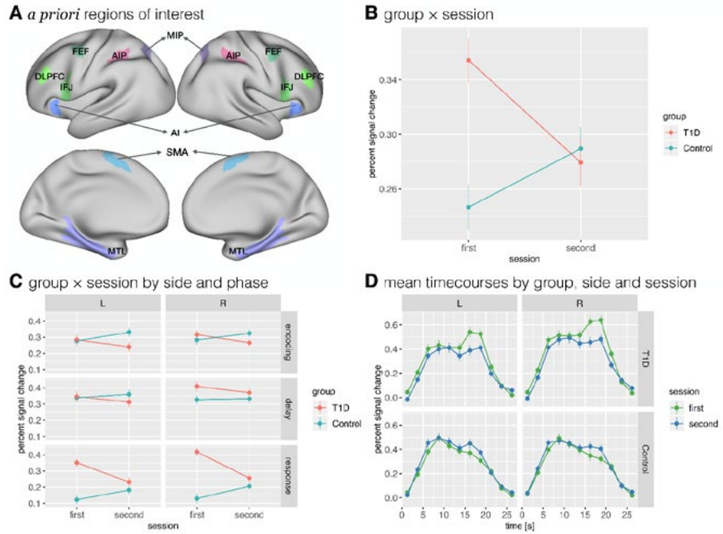
Jasna Šuput Omladič

Acute hyperglycemia and memory in adolescents with T1D

The objective of our study was to investigate the effect of a rapid rise in blood sugar on brain function in adolescents with type 1 diabetes (T1D). Acute hyperglycaemia negatively affects the capacity of spatial working memory, and may interfere with daily functioning and reduce school performance of this age group with T1D. A possible mechanism of this completely new finding is microedema in key areas of the brain.



*Differences in brain activation as assessed by functional MRI during the performance of a spatial working memory task between adolescents with T1D and healthy control subjects. **A** shows a priori regions of interest. **B** presents the change of activation in regions of interest during a session in (1) normal and (2) elevated blood sugar in the T1D group and the healthy control group. **C** presents change of activation in the regions of interest in (1) normal and (2) elevated blood sugar relative to the memory phase and hemisphere. **D** presents the activation of regions of interest in time by group, session, and hemisphere. FEF, frontal eye field; SMA, supplementary motor area; AI, anterior insula; AIP, anterior intraparietal area; MIP, medial intraparietal area; IFJ, inferior frontal junction; DLPFC, dorsolateral prefrontal cortex; MTL, medial temporal lobe.*

Dr. Jasna Šuput Omladič, University clinical centre Ljubljana (jasna.suputomladic@kclj.si)

Source: Šuput Omladič Jasna, Slana Ozimič Anka, Vovk Andrej et al. Acute hyperglycemia and memory in adolescents with TID. Diabetes Care 2020;43.
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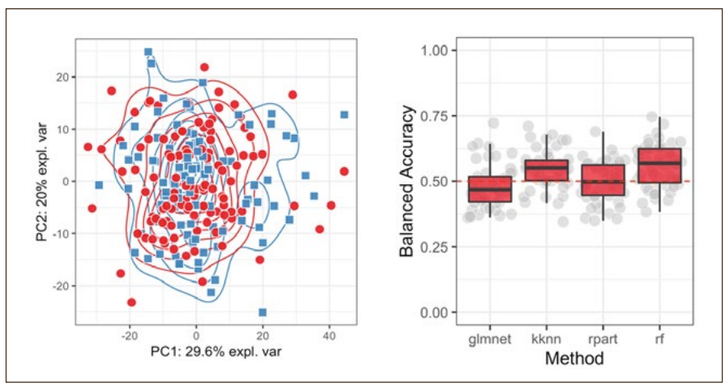
Dr. Tea Lanišnik Rižner

Multiplex analysis of 40 cytokines does not allow for differentiation between endometriosis patients and controls

Endometriosis is a common gynaecological condition characterized by severe pelvic pain and/or infertility. The current gold standard for diagnosis is an invasive laparoscopic procedure, and thus the development of non-invasive approaches is urgently needed. Endometriosis is an inflammatory disease where different inflammatory cytokines represent potential diagnostic biomarkers. We evaluated 40 different cytokines in plasma samples of 210 patients (116 with endometriosis; 94 controls) from Slovenian and Austrian populations. Results of the univariate statistical analysis and principal component analysis showed no differences in concentrations of these cytokines and allowed for no clear separation between patients and controls. We trained four machine learning algorithms (decision tree, linear model, k-nearest neighbour, random forest) on plasma levels of proteins and patients' clinical data. The constructed models did not differentiate between patients with endometriosis and controls with sufficient sensitivity and specificity. This study thus indicates that plasma levels of the selected cytokines have limited potential for diagnosis of endometriosis and suggests that future biomarker discovery studies should focus on omics approaches. Endometriosis significantly impairs health-related quality of life and work productivity. Non-invasive diagnostic test would allow for earlier diagnosis and treatment, and would reduce disease progression and associated infertility, thus leading to ground-breaking effects on patients' lives.



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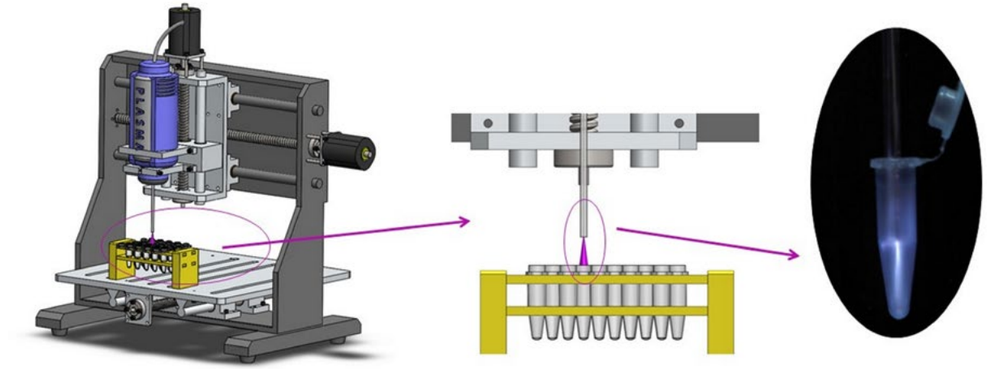
Source: Knific Tamara, Fishman Dmytro, Vogler Andrej, Gstöttner Manuela, Wenzl René, Peterson Heidi in Lanišnik Rižner Tea, Multiplex analysis of 40 cytokines do not allow separation between endometriosis patients and controls. Scientific Reports, 9:16738, 2019.
Hyperlink: https://www.nature.com/articles/s41598-019-52899-8

Natural sciences | Engineering sciences | Medical sciences | Biotechnical sciences | Social sciences | Humanities | Interdisciplinary research

Dr. Ita Junkar

Method for treatment of tools used for isolation of microvesicles, nanovescicles or exsomes

Microvesicle (MV) diagnostics has gained in importance as it enables the detection of different diseases of the modern world, such as cancer and cardiovascular disease. The method enables the detection of disease far before the first symptoms occur. However, this highly prospective filed of research lacks the desired MV yields, which hampers their detection. Commonly, expensive and time-consuming chemical or biological procedures are employed, which require high volumes of biological fluids. The highest loss of isolated MV occurs on the walls of different medical materials used for its isolation (such as Eppendorf tubes). With the development of innovative technology based on surface treatment of the inner side of the medical tools with high pulses of charged particles, significant reduction in adhesion of MV is achieved, and their detection is increased threefold. This innovative method has been protected by European patent and has an immense potential in medical diagnostics.



Developed prototype and granted European patent for the method for treatment of polymeric tools used for isolation of microvesicles used in diagnostics.

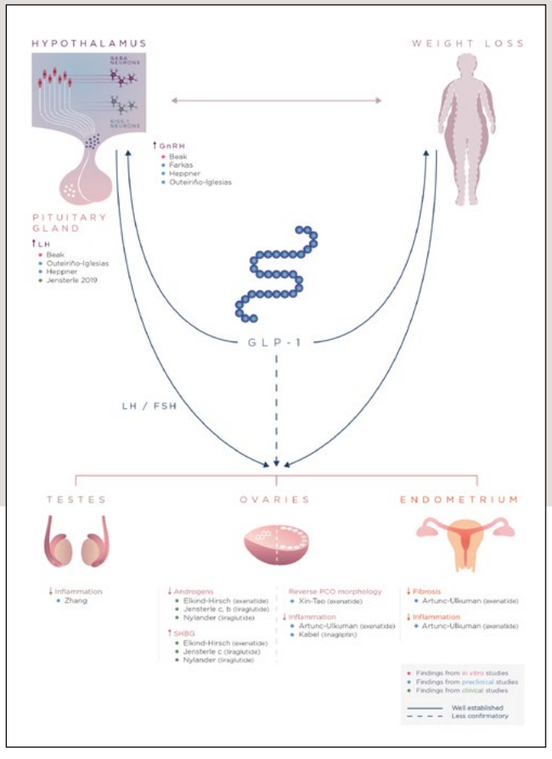
Dr. Ita Junkar, "Jožef Stefan" Institute (ita.junkar@ijs.si)

Source: JUNKAR, Ita, KRALJ-IGLIČ, Veronika, ŠTUKELJ, Roman, ZAPLOTNIK, Rok, MOZETIČ, Miran. Method for treatment of tools and tools used for isolation of microvesicles, nanovescicles or exsomes = Verfahren zur Behandlung von Werkzeugen und Werkzeuge zur Isolierung von Mikrovesikeln, Nanovesikeln oder Exomen = Procédé pour le traitement d'outils et outils utilisés pour l'isolement de microvésicules, de nanovésicuels ou d'exosomes: European patent specification EP 3 185 921 B1, 2019-09-04. München: European Patent Office, 2019. 13 pp.
Hyperlink: https://data.epo.org/gpi/EP3185921B1-METHOD-FOR-TREATMENT-OF-TOOLS-AND-TOOLS-USED-FOR-ISOLATION-OF-MICROVESICLES--NANOVESICLES-OR-EXOSOMES

Dr. Mojca Jensterle Sever

The role of glucagon-like peptide-1 in reproduction: from physiology to therapeutic perspective

Metabolism and reproduction are fundamental and interdependent aspects of mammalian physiology. Adequate metabolic homeostasis is important for reproductive health. Both energy deficiency and hypercaloric conditions are associated with decreased fertility. The article investigated signalling between the metabolic and reproductive systems via glucagon-like peptide (GLP-1). GLP-1 is a hormone that is released from the gut after nutrient intake and stimulates insulin secretion, while centrally suppressing appetite and slowing gastric emptying. In obesity, the secretion and efficacy of GLP-1 are reduced. GLP-1 agonists are used to treat diabetes and obesity. Pharmacologically stimulated GLP-1 causes weight loss mainly due to an inhibitory central effect on the appetite. The resulting weight loss has beneficial effects on the reproductive axis. For the first time, the article highlights the possible additional direct effect of GLP-1 on the reproductive axis, which goes beyond the beneficial effects of weight loss: 1) GLP-1 at the hypothalamic level directly stimulates the secretion of GNRH and consequently LH; 2) GLP-1 has beneficial anti-inflammatory and antifibrotic effects on the testes, ovaries and endometrium; 3) GLP-1 agonists reduce the serum concentration of androgens and their bioavailability in women with polycystic ovary syndrome, which is often associated with reduced fertility and obesity. The role of GLP-1 agonists on spermatogenesis remains unexplored, as a potential negative effect on spermatogenesis has been reported in individual men, contrary to findings in preclinical model.



The effects of GLP-1 on the reproductive axis
Key: Full arrows indicate well-established relationships, and the broken arrow shows a relationship that has not been fully established thus far and requires further evaluation. The type of research is indicated with the colour of the dot before the reference. Abbreviations: GLP-1, glucagon-like peptide-1; GnRH, gonadotrophic releasing hormone; LH, luteinizing hormone; FSH, follicle-stimulating hormone; SHBG, sex hormone-binding globulin; PCO, polycystic ovary

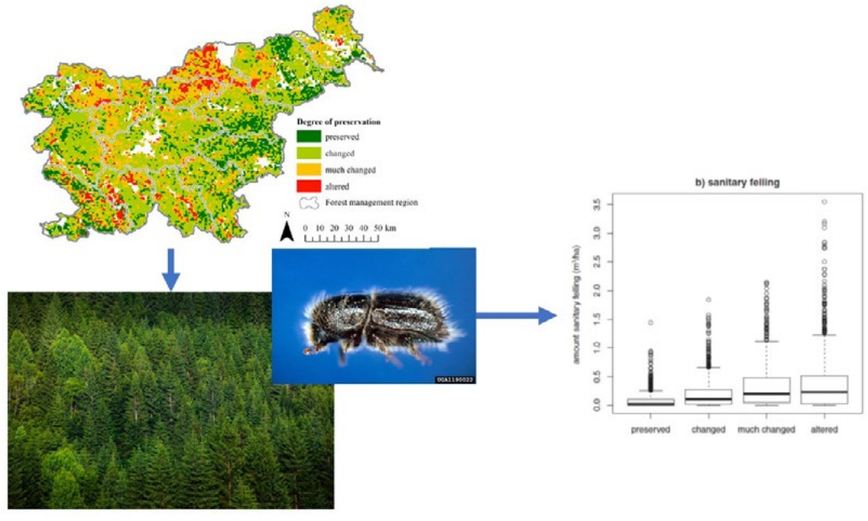
Dr. Mojca Jensterle Sever, University Clinical Centre Ljubljana (mojcajensterle@yahoo.com)

Source: JENSTERLE SEVER, Mojca, JANEŽ, Andrej, FLIERS, Eric, DEVRIES, J. Hans, VRTAČNIK-BOKAL, Eda, SIEGELAAR, Sarah E. The role of glucagon-like peptide-1 in reproduction: from physiology to therapeutic perspective. Human reproduction update, ISSN 1355-4786, Jul. 2019, vol. 25, no. 4, pp. 504-517, doi: 10.1093/humupd/dmz019. [COBISS.SI-ID 34390233]
Hyperlink: https://pubmed.ncbi.nlm.nih.gov/31260047/

Dr. Maarten De Groot

Forest management history is an important factor in bark beetle outbreaks: Lessons for the future

Forest management in the past affects current state of the forest and consequently the outbreaks and the spread of forest pests. In this study we investigated whether the forest management in the past and the management of Norway spruce (Picea abies L.) affect the potential outbreaks of European spruce bark beetles after large scale disturbances (windthrow, ice storms). We also checked if the proportion of Norway spruce in the environment and the altitude affected the outbreak. We found that there was a relationship between the change in tree species composition and the sanitary felling due to bark beetles. In epidemical situations, sanitary felling was higher in lower altitudes and in areas with higher proportion of Norway spruce. We also showed that the proportion of realized cut compared to the planned cut was negatively associated with the sanitary felling. Therefore, we suggest that monocultures of Norway spruce be changed into a mixed forest stand, and to improve forest management so as to increase forest resistance against bark beetles.



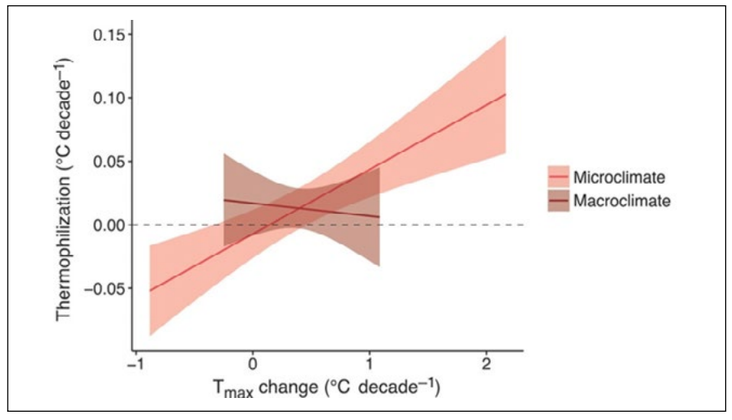
Dr. Maarten De Groot, Slovenian Forestry Institute (maarten.degroot@gozdis.si)

Source: DE GROOT, Maarten, DIACI, Jurij, OGRIS, Nikica. Forest management history is an important factor in bark beetle outbreaks: Lessons for the future. Forest Ecology and Management. [Print ed.]. feb. 2019, vol. 433, str. 467–474, ilustr. ISSN 0378-1127.
Hyperlink: https://www.sciencedirect.com/science/article/abs/pii/S037811271831675X

Dr. Thomas Nagel

Forest microclimate dynamics drive plant responses to warming

Global warming is causing shifts in biodiversity in favour of thermophilic species. Responses of plant species are often slower than the rate of climate warming, but the reasons for this remain largely unknown. Through decades of microclimate research on 2,955 plots in temperate European forests, this study demonstrates that the thermophilization of forest plant communities is primarily controlled by the microclimate. Increasing the tree canopy cover reduces rates of warming within forests, whereas rapid loss of forest canopies causes increased local heat stress, leading to a large imbalance between plant community composition and climate change, and may lead to loss of understory plant diversity. The relationship between plants and microclimates is key to the understanding the implications of climate change on biodiversity. Maintaining the forest's natural cover and vertical structure protects forest biodiversity from rapid climate warming and enables the gradual adaptation of plant species to warmer climates.



Thermophilization in forest understory plant communities is associated with microclimate change and not with macroclimate change. The degree of thermophilization increases with increasing microclimate warming of maximum temperature during the growing season and is not statistically related to the rate of macroclimate warming.

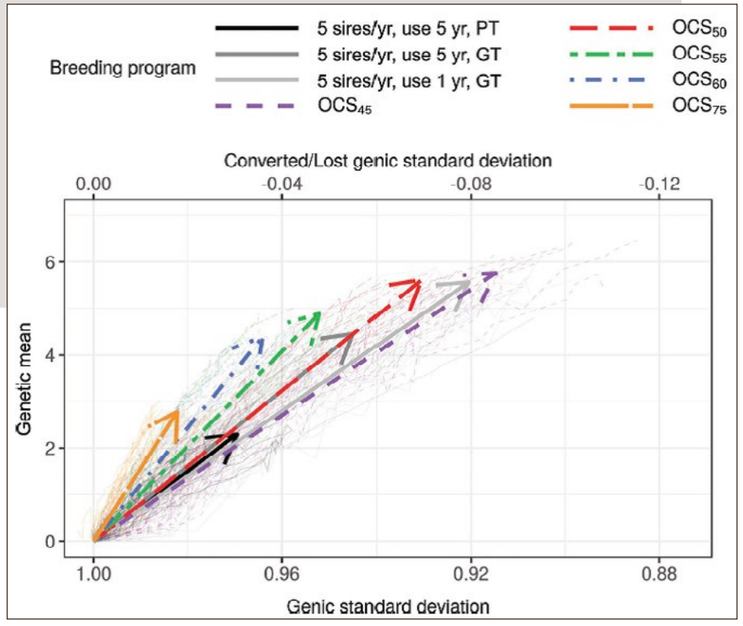
Dr. Thomas Nagel, University of Ljubljana, Biotechnical Faculty (tom.nagel@bf.uni-lj.si)

Source: Zellweger, F., De Frenne, P., Lenoir, J., Vangansbeke, P., Verheyen, K., Bernhardt-Römermann, M., Baeten, L., Hédl, R., Berki, I., Brunet, J., Van Calster, H., Chudomelová, M., Decocq, G., Dirnböck, T., Durak, T., Heinken, T., Jaroszewicz, B., Kopecký, M., Máliš, F., Macek, M., Malicki, M., Naaf, T., Nagel, T.A., Ortmann-Ajkai, A., Petřík, P., Pielech, R., Reczyńska, K., Schmidt, W., Standovár, T., Świerkosz, K., Teleki, B., Vild, O., Wulf, M., Coomes, D., 2020. Forest microclimate dynamics drive plant responses to warming. Science 368, 772.
Hyperlink: https://pubmed.ncbi.nlm.nih.gov/32586991/

Dr. Jana Obšteter

Efficient use of genomic information for sustainable genetic improvement in small cattle populations

Genomic selection is a well-established technology in large populations and has doubled the genetic gain in cattle. However, small populations still struggle with its implementation mainly due to the lack of financial resources and sustainable strategy. We used simulation to explore how to implement efficient genomic selection that would ensure short- and long-term genetic gain. We have shown that small populations can increase short-term genetic gain by implementing the genomic selection of sires, faster turn-over of sires, and by increasing the intensity of sire selection. However, some of these strategies did not prove to be sustainable. We can improve the sustainability of selection and long-term genetic gain with simultaneous use of progeny and genomically tested sires, and with faster turn-over of sires. We can further increase the long-term genetic gain by optimizing the selection and use of sires. The results will help breeding organizations implement a sustainable genomic selection.



Dr. Jana Obšteter, Agricultural Institute of Slovenia (jana.obsteter@kis.si)

Source: OBŠTETER, Jana, JENKO, Janez, HICKEY, John M., GORJANC, Gregor. Efficient use of genomic information for sustainable genetic improvement in small cattle populations. Journal of dairy science, ISSN 0022-0302, 2019, vol. 102, iss. 11, 9971-9982, illustr., doi: 10.3168/jds.2019-16853. [COBISS.SI-ID 5863784].
Hyperlink: https://pubmed.ncbi.nlm.nih.gov/31477287/

Dr. Marjeta Čandek Potokar

Environmental impacts of pig production systems using European local breeds: the contribution of carbon sequestration and emissions from grazing

In the context of societal challenges related to sustainable management of agricultural genetic resources, the project TREASURE, coordinated by the Agricultural Institute of Slovenia (KIS), addressed the environmental impact of production systems of local pig breeds which are adapted to local agroclimatic conditions, as their environmental footprint is poorly documented in the literature. In collaboration with INRAe and Universita di Bologna, a study was conducted in three local pig breeds: French Gascon, Italian Mora Romagnola and Slovenian Krškopolje pig, to assess their environmental impact, including carbon sequestration and emissions due to grazing. Using the life cycle analysis modelling tool, global (greenhouse gas emissions) and local impacts (eutrophication, acidification), as well as energy and land use were assessed. In this analysis, the functional unit is the key element to express environmental impact indicators, with most studies giving estimates per kg of product, rather than per ha of land used. In our study, we made both estimates. In terms of global warming, the smallest environmental footprint was observed in Gascon breed farms and the largest in Mora Romagnola farms. Krškopolje pig farms occupied an intermediate position, however, they showed the largest impact on acidification and the smallest on eutrophication. Low emissions from grazing were found for all breeds, but also a negligible contribution to carbon sequestration was found. Compared to intensive production systems typical of modern pig breeds, farming with local pig breeds represents a smaller environmental footprint per unit of land used, but a higher one per unit of product due to the low production intensity. Extensive production systems, typical of local pig breeds, and the intensive production systems each have their own advantages, but neither is environmentally neutral. In the case of local pig breeds, the reserves for mitigating the environmental impact lie in the greater use of home-grown and alternative feed sources, and in optimising the diet according to the growth curve and protein requirements ("precision feeding").

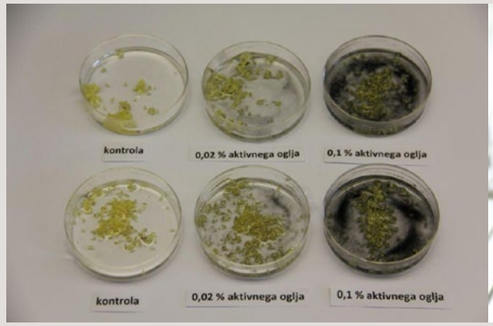
Dr. Marjeta Čandek Potokar, Agricultural Institute of Slovenia (meta.candek-potokar@kis.si)

Source: MONTEIRO, Alessandra Nardina Trícia Rigo, WILFART, Aurélie, UTZERI, Valerio Joe, BATOREK LUKAČ, Nina, TOMAŽIN, Urška, NANNI COSTA, Leonardo, ČANDEK-POTOKAR, Marjeta, FONTANESI, Luca, GARCIA-LAUNAY, Florence. Environmental impacts of pig production systems using European local breeds: the contribution of carbon sequestration and emissions from grazing. Journal of cleaner production, ISSN 0959-6526. 2019, vol. 237, art. no. 117843, pp. 1-9.
Hyperlink: https://www.sciencedirect.com/science/article/abs/pii/S0959652619327097X

Dr. Katarina Rudolf Pirih

Innovative hybrid breeding method for vegetable and crop plants based on genotyping, interpollination, phenotyping and paternity testing of selected elite f1 hybrids: presented on breeding f1 cabbage hybrid varieties

Hybrid seed production is predominant in modern agriculture. Hybrids are chosen to improve the characteristics of the resulting plants, such as better yield, greater uniformity and they are a form of intellectual property. Breeding methods are complex and time consuming. The major bottleneck is testing which two of many inbred lines are the most suitable parents for a new hybrid variety. The proposed method allows a larger scope of testing for combined abilities. The method includes conventional and biotechnological approaches in order to optimise the production of interesting hybrids. According to our results, we can compete with the leading seed companies in the world. We are trying to protect the intellectual property with a USA patent, in 2019 we published an article in the journal Frontiers in Plant Science and in 2020 a new hybrid variety named Rožnik was registered.



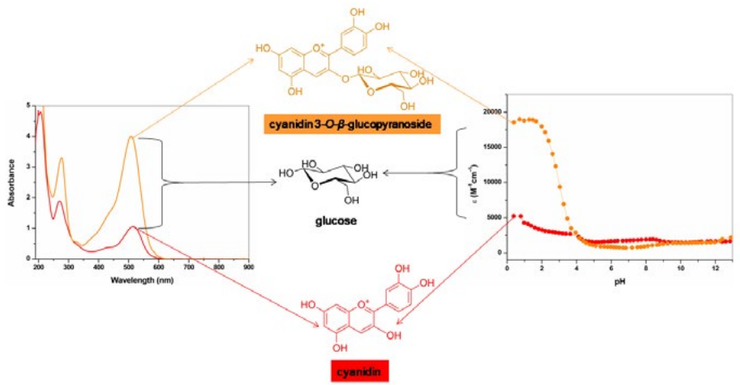
Dr. Katarina Rudolf Pilih, University of Ljubljana, Biotechnical Faculty (katarina.rudolfpilih@bf.uni-lj.si)

Source: RUDOLF PILIH, Katarina, PETKOVŠEK, Marko, JAKŠE, Jernej, ŠTAJNER, Nataša, MUROVEC, Jana, BOHANEC, Borut. Proposal of a new hybrid breeding method based on genotyping, inter-pollination, phenotyping and paternity testing of selected elite F1 hybrids. Frontiers in plant science. 2019, art. 1111, vol. 10, str. 1-12 [COBISS.SI-ID 9287289].
Hyperlink: https://www.frontiersin.org/articles/10.3389/fpls.2019.01111/full

Dr. Nataša Poklar Ulrih

pH-induced structural forms of cyanidin and cyanidin 3-O-ß-glucopyranoside

Anthocyanins are natural plant pigments that are also used in the food industry. Chemically, they are glycosylated polyhydroxy and polymethoxy derivatives of 2-phenylbenzopyrylium (flavylium) salts. As a natural food colorant, they are used for various products in sugar confectionery, jams, and bakery toppings, as well as in yogurt drinks and some mixed fruit juices. In foods containing anthocyanins as natural food colorants, a number of reactions can occur that affect their colour. The colour of anthocyanins, and thus the colour of the food, can be affected by several factors, particularly temperature, oxygen, light, and pH. In a published study, we describe the results of the effect of pH on the structural transformations of one of the most abundant anthocyanins in berries, cyanidin 3-O-ß-glucopyranoside, and its deglycosylated form, cyanidin. Multivariate data analysis of UV-Vis spectra in the pH range from 0.4 to 13.5 identified seven structural forms for cyanidin, while six structural forms were identified for Cy3Glc while one was not. Degradation products formed from both compounds at different pH values, and times were identified. While cyanidin-3-O-ß-glucoside was the most stable in aqueous buffer solution at pH 2.0 and the most unstable at pH 9.0, cyanidin was 97 % degraded in buffer solution at pH 2.0.
Due to the growing consumer demand for food without artificial additives, manufacturers are also becoming more interested in using natural pigments, which must be stable in food. Knowledge of the influence of environmental parameters on the stability of natural pigments enables their controlled use in food.



Dr. Nataša Poklar Ulrih, University of Ljubljana, Biotechnical Faculty (natasa.poklar@bf.uni-lj.si)

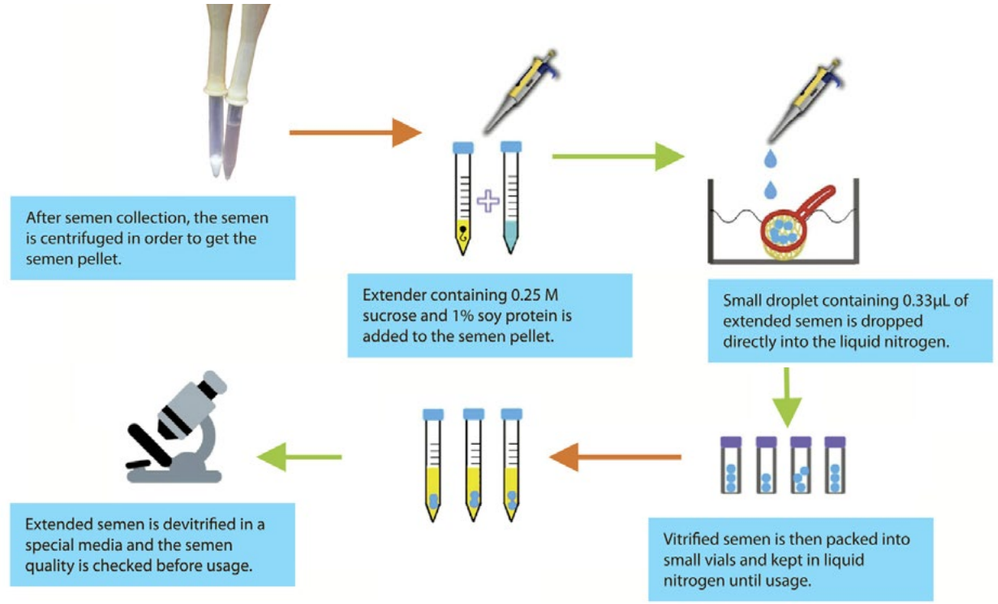
Source: RAKIĆ V., RINNAN Å., POLAK T., SKRT M., MILJKOVIĆ M., POKLAR ULRIH N. pH-induced structural forms of cyanidin and cyanidin 3-O-[beta]-glucopyranoside. Dyes and pigments, 2019, vol. 165, pp. 71-80.
Hyperlink: https://www.sciencedirect.com/science/article/abs/pii/S0143720818313275

Natural sciences | Engineering sciences | Medical sciences | Biotechnical sciences | Social sciences | Humanities | Interdisciplinary research

Dr. Maja Zakošek Pipan

Vitrification using soy lecithin and sucrose: a new way to store the sperm for the preservation of canine reproductive function

The study shows the success of vitrification of canine semen using diluents in which soy lecithin was used for vitrification instead of proteins of animal origin. This is important in veterinary medicine from the point of view of international semen transport, as many countries do not allow the importation of semen if animal proteins are present. In addition, the vitrification process is simpler and less time consuming than conventional methods of semen freezing and can be performed without the sophisticated equipment otherwise required by conventional methods of semen storage.
The study presented here is the first study of its kind on canine semen and one of the few in dogs in which we have successfully preserved canine semen using the vitrification process and equated the quality of the semen with previously used slow freezing methods. Due to the similarity in the composition of human and canine sperm, the implementation of our research findings and the appropriate modification of the existing human sperm vitrification procedure offers opportunities to improve clinical outcomes of semen freezing in human reproductive medicine. In human medicine, sperm storage is particularly important in young oncological patients prior to chemotherapy and radiotherapy, as such treatment can permanently damage the testis and impair spermatogenesis. Thus, with proper semen vitrification before oncological therapy, we can preserve the patient's ability to reproduce and thus enable him to have a normal family life.



Dr. Maja Zakošek Pipan, University of Ljubljana, Faculty of Veterinary Medicine (maja.zakosekpipan@vf.uni-lj.si)

Source: ZAKOŠEK Pipan, Maja, CASAL, Margret L., ŠTERBENC, Nataša, VIRANT-KLUN, Irma, MRKUN, Janko. Vitrification using soy lecithin and sucrose: a new way to store the sperm for the preservation of canine reproductive function. Animals, ISSN 2076-2615, Apr. 2020, vol. 10, iss. 4, pp. 1-15, illustr.
Hyperlink: https://www.mdpi.com/2076-2615/10/4/653/htm

Dr. Nadja Penko Seidl

Quantitative assessment of agricultural landscape heterogeneity

Landscape heterogeneity is a criterion of cultural landscape quality and an indicator of agricultural landscapes' biodiversity. To achieve these objectives, agricultural policy needs to support extensive traditional cultural practices whilst also ensuring a sufficient share of natural habitats in the landscape. A method for assessing the landscape heterogeneity of agricultural landscapes is presented in this article. It was developed within the CRP project V4-1434: Definition of landscape heterogeneity and landscape characteristics significant for the preservation of biodiversity. What makes this approach innovative is its consideration of landscape features' heterogeneity with regard to supplementing land cover heterogeneity. The land cover heterogeneity is defined as a function of number and the distribution of land cover categories (compositional and configurational heterogeneity), whereas landscape feature heterogeneity is a function of their diversity and number of features.
In addition to its research significance, the proposed list of landscape features together with the Landscape Heterogeneity Assessment Index serves as the basis for the development of agricultural and environmental policy measures, as well as for the assessment and monitoring of the effects of these measures on landscape heterogeneity.

Dr. Nadja Penko Seidl, University of Ljubljana, Biotechnical Faculty (nadja.penko@bf.uni-lj.si)

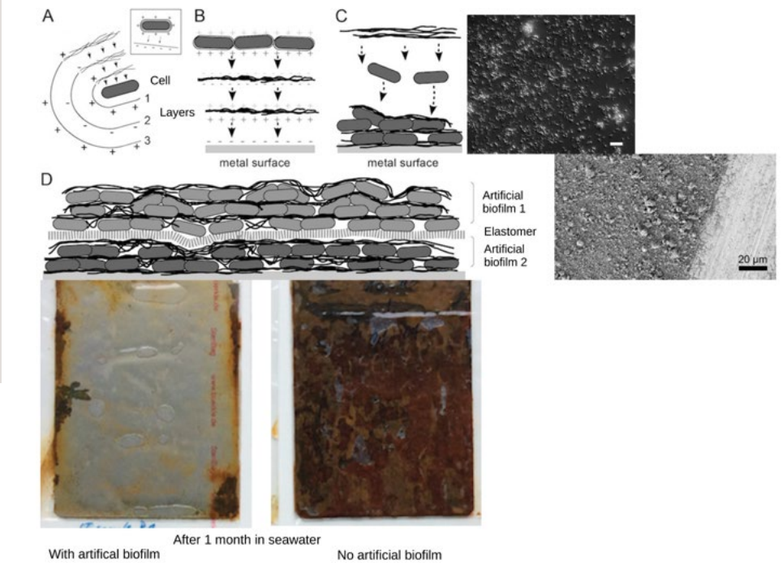
Source: PENKO SEIDL, Nadja, GOLOBIČ, Mojca. Quantitative assessment of agricultural landscape heterogeneity. Ecological indicators: integrating monitoring, assessment and management. 2020, vol. 112, art. no. 106115, pp. 1-7.
Hyperlink : https://www.sciencedirect.com/science/article/pii/S1470160X20300522

Natural sciences | Engineering sciences | Medical sciences | Biotechnical sciences | Social sciences | Humanities | Interdisciplinary research

Dr. Aleš Lapanje

Natural Microbial Communities Can Be Manipulated by Artificially Constructed Biofilms

Surface fouling and biofilm formation is one of the biggest problems in industry, healthcare and transportation, as it causes a lot of damage due to reduced vessel floating, material deterioration, nosocomial infections, corrosion, etc.
Currently, the only approach against microbial fouling is to prevent microbe attachment or inactivate them. Various physicochemical approaches are used, but they are hazardous to the environment and humans and unsuccessful in the long run, since biofilms are developed after such treatments.
Given that we now know many aspects of the formation of biofilms on surfaces, we made a mental leap in this research by developing methods that allow spatial and industrially relevant positioning of microbes. Contrary to the doctrine, in our approach, we changed the surface in such a way that we were able to intentionally coat it with microbes that can direct the process of biofilm succession on the metal surfaces, resulting in the elimination of microbes that cause corrosion.



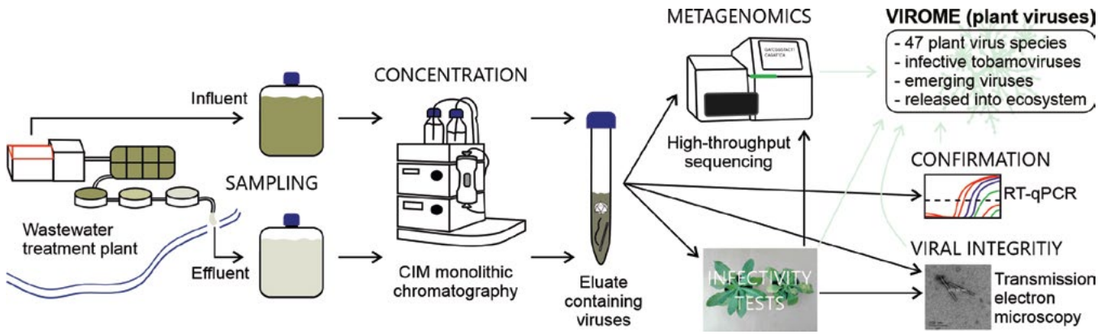
Dr. Aleš Lapanje, Jožef Stefan Institute (ales.lapanje@ijs.si)

Source: RIJAVEC, Tomaž, ZRIMEC, Jan, SPANNING, Rob van, LAPANJE, Aleš. Natural microbial communities can be manipulated by artificially constructed biofilms. Advanced science. 2019, vol. 6, iss. 22, 12 pp. ISSN 2198-3844.
Hyperlink: https://onlinelibrary.wiley.com/doi/full/10.1002/advs.201901408

Dr. Maja Ravnikar

Infectivity and diversity of plant viruses in wastewater

In wastewater samples we detected different organisms including 47 plant pathogenic viruses. We also demonstrated infectivity for some pathogenic viruses in influent and effluent samples and exposed the potential risks of the uncontrolled use of reclaimed water for irrigation. The results were published in leading journal Water Research. To concentrate the viruses, we used smart filters from Slovenian company BIA Separations, and we followed by high-throughput sequencing that enabled us to get an insight into the diversity of viruses in wastewater. Apart from plant infecting viruses, where we also found some that were never reported before in Slovenia (e.g. new emerging tomato brown rugose fruit virus), we also detected bacteriophages and human pathogenic viruses causing gastrointestinal infections. Infectivity of plant viruses that are causing great losses especially in tomato and pepper production, has been confirmed in wastewater for the first time. These results are calling for cautious use of reclaimed water in agriculture. The described methods can also be used to monitor SASR-CoV-2 in wastewater.



Dr. Maja Ravnikar, National Institute of Biology (maja.ravnikar@nib.si)

Source: BAČNIK, Katarina, KUTNJAK, Denis, PECMAN, Anja, MEHLE, Nataša, TUŠEK-ŽNIDARIČ, Magda, GUTIÉRREZ-AGUIRRE, Ion, RAVNIKAR, Maja. Viromics and infectivity analysis reveal the release of infective plant viruses from wastewater into the environment. Water research. [Print ed.]. 2020, vol.177, 41 pp., ISSN 0043-1354.
Hyperlink: https://www.sciencedirect.com/science/article/pii/S0043135420301640

Dr. Zdenko Kodelja

Violence in schools: zero tolerance policies

The article, which is the result of research work in the field of philosophy of education, brings a new, critical and philosophically reflected view on the theory and practice of zero tolerance policies in school. In terms of content, it deals mainly with the following problem: on the one hand, there is a broad consensus that violence in schools is something so morally wrong that it should not be tolerated. Therefore, the intolerance shown by a teacher towards violent behaviour of students in school could be understood not only as a virtue but also as the teacher's moral duty and legal obligation. On the other hand, extreme tolerance of an evil such as violence becomes a vice when, for instance, a teacher allows an innocent student to become a victim of physical or verbal violence perpetrated by other students. Therefore, the very idea of "zero tolerance" policies seems to be correct, although the results of its application in practice have repeatedly proved to be problematic, ineffective and unfair

Dr. Zdenko Kodelja, Educational Research Institute (zdenko.kodelja@pei.si)

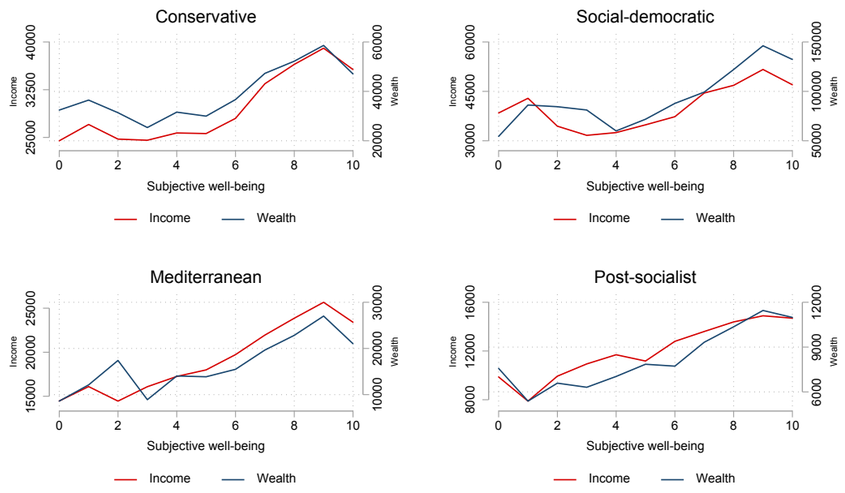
Source: KODELJA, Zdenko. Violence in schools: zero tolerance policies. Ethics and education. 2019, vol. 14, iss. 2, pp. 247-257. ISSN 1744-9650.
Hyperlink: https://www.tandfonline.com/doi/full/10.1080/17449642.2019.1587682

Dr. Miroslav Verbič

The Effect of Income and Wealth on Subjective Well-Being in the Context of Different Welfare State Regimes

The article discusses the topic economists pay the most attention to in the context of subjective well-being research, namely the effect of economic standing on subjective well-being. To carry out the analysis, data from the Survey of Health, Aging and Retirement in Europe (SHARE) were used, which allowed the analysis to be placed into the context of different welfare state typologies (Conservative, Mediterranean, Post-socialist and Social-democratic). Using the longitudinal dimension of the dataset, as well as instrumental variables, it was found that the direction of bias in ordinary least squares estimates is negative, which supports the notion that income is positively correlated with variables, such as for example working hours, which negatively affect subjective well-being. Furthermore, it was found that the welfare regime has a significant impact on the effect of income and wealth on subjective well-being, which confirms that the welfare state is linked to subjective well-being through its instruments of decommodification and stratification. Finally, the results suggest caution when studying the relationship between economic standing and subjective well-being across multiple countries.
The article is the first to simultaneously examine the causal effect of income and wealth on subjective well-being in countries with different welfare state regimes. Because it addresses important drawbacks of studies conducted on cross-sectional data, it can be relevant to policy makers who shape social policy, which can improve an individual's subjective well-being.

Average income and net wealth (€) at different subjective well-being levels (0–10) by welfare regime type



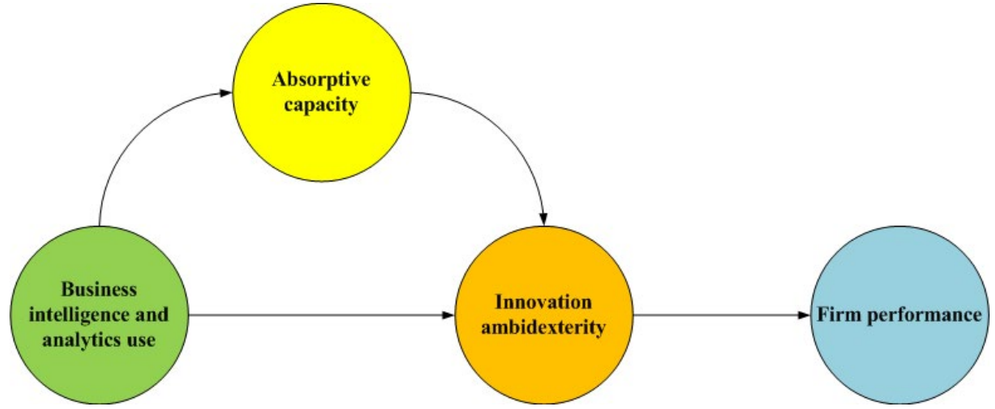
Dr. Miroslav Verbič, University of Ljubljana, School of Economics and Business (miroslav.verbic@guest.arnes.si)

Source: DOMINKO, Miha, VERBIČ, Miroslav. The effect of income and wealth on subjective well-being in the context of different welfare state regimes. Journal of happiness studies. 2020. ISSN 1389-4978. DOI: 10.1007/s10902-020-00225-9.
Hyperlink: https://link.springer.com/article/10.1007/s10902-020-00225-9

Dr. Katerina Božič, dr. Vlado Dimovski

Business intelligence and analytics use, innovation ambidexterity, and firm performance: A dynamic capabilities perspective

The article examines the role of using business intelligence and analytics in managing different innovative activities, called innovation ambidexterity. Based on the theoretical perspective of dynamic capabilities and the process theory of information systems value creation, the authors found that the use of business intelligence and analytics is directly positively related to innovation ambidexterity through increased opportunities for experimentation and prediction. In addition to the direct relationship, absorptive capacity positively mediates the relationship between the use of business intelligence and analytics and innovation ambidexterity through increased variety and detail of information. Due to the increased availability of data and information, managers can use business intelligence and analytics to support absorptive knowledge capacity and related knowledge creation processes. The insights and knowledge gained using business intelligence and analytics can be used to (i) achieve greater flexibility by experimenting with products or services more quickly; and (ii) improve the prediction of the value of new products and services (by reducing the variability of sampling factors and links between them).



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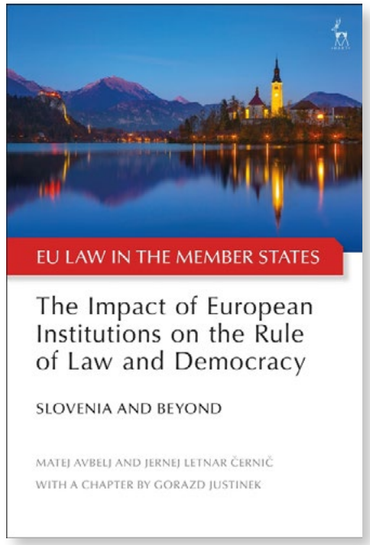
Source: Božič, K. and Dimovski, V. (2019), "Business intelligence and analytics use, innovation ambidexterity, and firm performance: A dynamic capabilities perspective", The Journal of Strategic Information Systems, Vol. 28 No. 4, p. 101578.
Hyperlink:https://www.sciencedirect.com/science/article/abs/pii/S0963868718303652?casa_token=_RmUzQJfjrcAAAAA:vDGIR2limp8Jby8gcfPgIhwOuZ_fB5-zSXs04c-izXfy6N3jL9jGOOGMLtB8gFfFqcVqH72hvq4

Dr. Matej Avbelj, dr. Jernej Letnar Černič

The Impact of European Institutions on the Rule of Law and Democracy: Slovenia and Beyond



Since 2010 the European Union has been plagued by crises of democracy and the rule of law, which have been spreading from Central and Eastern Europe (CEE), catching many by surprise. This book argues that the professed success of the 2004 big bang enlargement mirrored the Potemkin villages erected in the new Member States on their accession to Europe. Slovenia is a prime example. Since its independence and throughout the accession process, Slovenia has been portrayed as the poster child of the 'New Europe'. This book claims that the widely shared narrative of the Slovenian EU dream is a myth. In many ways, Slovenia has fared even worse than its contemporary, constitutionally-backsliding, CEE counterparts. The book's discussion of the depth and breadth of the democratic crises in Slovenia should contribute to a critical intellectual awakening and better comprehension of the real causes of the present crises across the other CEE Member States, which threaten the viability of the EU and Council of Europe projects. It is only on the basis of this improved understanding that the crises can be appropriately addressed at national, transnational and supranational levels.

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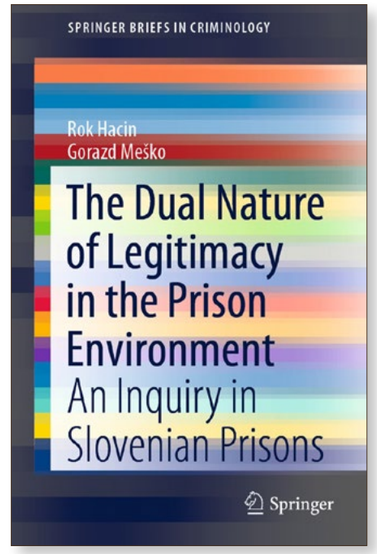
Source: Avbelj, M., & Černič, J.L., with a chapter by Gorazd Justinek (2020). The Impact of European Institutions on the Rule of Law and Democracy: Slovenia and Beyond (EU Law in the Member States). Oxford: Hart Publishing.
Hyperlink: https://www.bloomsburycollections.com/book/the-impact-of-european-institutions-on-the-rule-of-law-and-democracy-slovenia-and-beyond/

Natural sciences | Engineering sciences | Medical sciences | Biotechnical sciences | Social sciences | Humanities | Interdisciplinary research

Dr. Gorazd Meško, dr. Rok Hacin

The dual nature of legitimacy in the prison environment: An inquiry in Slovenian prisons

In 2020, the scientific monograph The dual nature of legitimacy in the prison environment: An inquiry in Slovenian prisons was published by Springer. The main purpose of the monograph is to present the first comprehensive study on the dual nature of legitimacy in prisons. Findings of the study, conducted in all Slovenian prisons and a correctional home, have confirmed the vital role of interpersonal relations in prison, which affect both natures of legitimacy – self-legitimacy of the prison staff (i.e., professional self-image) and prisoners' perception of legitimacy of prison workers (recognition of authority). Deriving from the study's results, a new theoretical model of the dual nature of legitimacy in the prison environment, based on the quality of relations between the prison staff and prisoners, was formed. Findings are also useful for practice, as they highlight the importance of humane treatment of prisoners, which leads to the development of good relations between prisoners and prison workers and consequently has a positive impact on order and compliance with rules within the institution.



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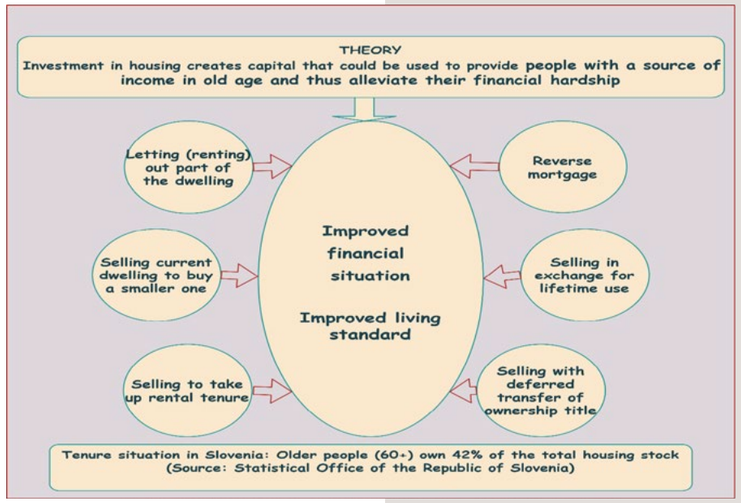
Source: Hacin, R. in Meško, G. (2020). The dual nature of legitimacy in the prison environment: An inquiry in Slovenian prisons. Cham: Springer.
Hyperlink: https://www.springer.com/gp/book/9783030328429

Dr. Richard Sendi, dr. Maša Filipovič Hrast, dr. Boštjan Kerbler

Asset-based welfare: Is housing equity release a viable option for pensioners in Slovenia

The changes in public funding systems that have taken place worldwide over the last three decades have had a major impact on the ability of countries to maintain the level of social protection as was afforded by previous welfare state policies. One of the theories recently advanced in this area relates to the concept of 'asset-based welfare'.



According to this theory, investing in housing creates capital that could be used to provide people with a source of income in old age and thus alleviate their financial hardship. Statistical data show that a large proportion of older people in Slovenia have considerable inactivated capital in the form of homeownership.
In the research, we investigated the probability of Slovenian pensioners to extract income from their residential property. The main aim of the survey was to examine the meaningfulness and acceptability of this concept for older people in Slovenia and to determine whether it can be introduced and implemented as a national housing policy instrument. The results of the research showed that the vast majority of respondents are not in favour of solutions that would derive from the asset-based welfare concept. This finding notwithstanding, these results do, nonetheless, provide an important basis for initiating serious discussions in the search for solutions that may include also the exploitation of the 'dead capital' embedded in homeownership.

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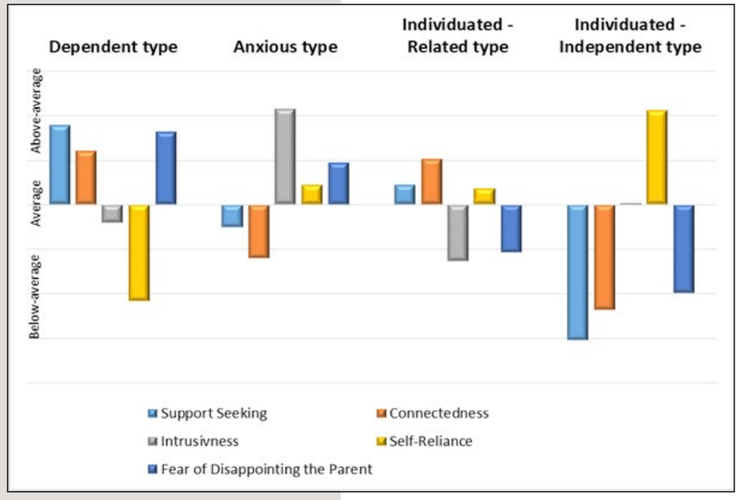
Source: Sendi, R., Filipovič Hrast, M., Kerbler, B.K.: Asset-based welfare: is housing equity release a viable option for pensioners in Slovenia. Journal of European social policy, ISSN 0958-9287, Oct. 2019, vol. 29, no. 4, pp. 577-589.
Hyperlink: https://journals.sagepub.com/doi/pdf/10.1177/0958928718804930

Natural sciences | Engineering sciences | Medical sciences | Biotechnical sciences | Social sciences | Humanities | Interdisciplinary research

Dr. Tina Kavčič, dr. Maja Zupančič

Identification of four types of individuation in emerging adults

Emerging adulthood is a newly defined developmental period, ranging from age 18 to 29 years. It is characterized by increasing independence from parents in the context of only few responsibilities and obligations toward others. As overtaking the adult roles is postponed into the late twenties, individuation in relation to parents also extends from adolescence into the twenties. Research in Slovenia has previously shown how this process in emerging adulthood differs qualitatively from individuation in adolescence, and a new valid measure (the ITEA, translated/adapted into multiple languages) was created. It also demonstrated invariant assessments of five developmentally specific aspects of individuation in emerging adulthood across different cultural contexts. To understand the dynamics of individuation, specific configurations of the key features of this process within individuals must be identified. We explored these configurations in a sample of 2040 Slovenian young people using the ITEA and two-step cluster analyses. Four qualitatively distinct, internally replicable, and structurally consistent types of individuation in relation to mother and father were found: dependent, anxious (both suggesting problems), individuated-related, and individuated-independent (different successful patterns). A half of the participants showed different individuation types in relation to mother and father, which has important implications for psychological practice. The findings contribute to our understanding and consideration of the dynamics of individuation in emerging adulthood, which is becoming an increasingly relevant topic in research, psychodiagnostics, and counselling as young people tend to live longer with their parents than decades ago, or at least notably depend on them. The research continues with Austrian and German emerging adults. In addition, the findings have important implications for psychological counselling and clinical practice with young people and their families.



Emerging adults exhibit 4 patterns of individuation characteristics in relation to their mother and father. The dependent type is overrepresented by younger women; the anxious type more likely includes men, single, younger unemployed and/or individuals residing with their parents; the individuated-related type is represented by older, employed and female emerging adults; and emerging adults classified to the individuated-independent type are more likely males, employed and living out of parental home.

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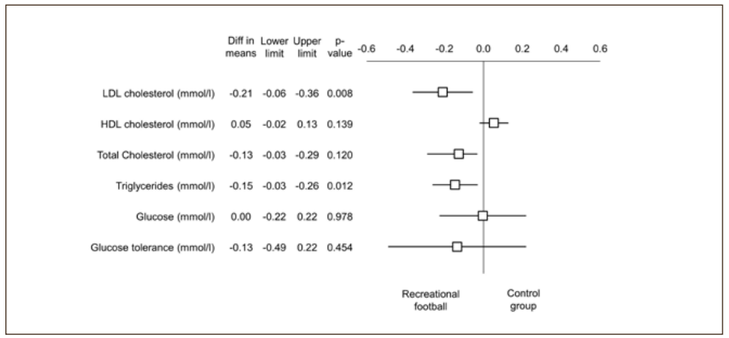
Source: Kavčič, T. in Zupančič, M. (2019). Types of separation-individuation in relation to mothers and fathers among young people entering adulthood. Journal of Youth Studies, 22(1), 66-86. [COBISS.SI-ID 1540327108].
Hyperlink: https://www.tandfonline.com/doi/abs/10.1080/13676261.2018.1478070

Dr. Zoran Milanović

Broad-spectrum physical fitness benefits of recreational football: a systematic review and meta-analysis

Most people consider football/soccer as professional type of sport while little is known that playing recreational football on a regular basis contributes to the improvement of public health. This type of recreational physical activity displays positive effects on health-related physical fitness including beneficial effects on cardiovascular, metabolic and muscle-skeletal health. Science proves that recreational football can be applied as an effective non-pharmacological treatment of lifestyle diseases. Participation in multi-faceted exercise training, such as recreational football, may be effective at simultaneously stimulating more than one fitness areas, thereby providing broad-spectrum fitness and health benefits. In addition, recreational football as game-play type of activity, might interest people more than traditional exercises and improve motivation and social aspect. Due to its broad-spectrum positive effects on fitness and overall health status, the "Football is Medicine" concept winning the "health benefit trophy" ahead of other exercises, falls under the wider movement concept "Exercise is Medicine".



Forest plot of the effect sizes and 95 % CIs of the changes in overall metabolic parameters. HDL, high-density lipoprotein; LDL, low-density lipoprotein.

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Source: MILANOVIĆ, Zoran, PANTELIĆ, Saša, ČOVIĆ, Nedim, SPORIŠ, Goran, MOHR, Magni, KRUSTRUP, Peter. Broad-spectrum physical fitness benefits of recreational football: a systematic review and meta-analysis. British journal of sports medicine, ISSN 0306-3674, 2019, vol. 53, iss. 15, pp. 926-939, illustr.
Hyperlink: https://bjsm.bmj.com/content/53/15/926

Dr. Jernej Mlekuž

The renaissance of sausage: the role of Kranjska sausage in the contemporary process of reconstructing the Slovenian nation

The article discusses the contemporary reconstruction of the Kranjska sausage as a national dish by exploring different actors in this process. This representative culinary object played a significant role in the formation and development of Slovene national consciousness from the Spring of Nations onward, faced devaluation in socialist era and experienced a renaissance in the new millennium, when it was also given a role in the project of the construction of the nation-state. The modern rebirth of the Kranjska sausage is presented as an interrelated and complex process due to many factors: the efforts of an influential ethnologist, the role of an institution dedicated to the Kranjska sausage, and other persons, groups and institutions with different objectives, ideas and understandings. The Slovenian nation, like any other nation, this article argues, was not created and reproduced only by politicians, writers, soldiers, poets, diplomats and other great men and women, but also by a blind and uncontrollable mass of nonhumans, among which the Carniolan sausage occupies a distinguished place.

Dr. Jernej Mlekuž, Slovenian Migration Institute, Research Centre of the Slovenian Academy of Sciences and Arts (mlekuz@zrc-sazu.si)

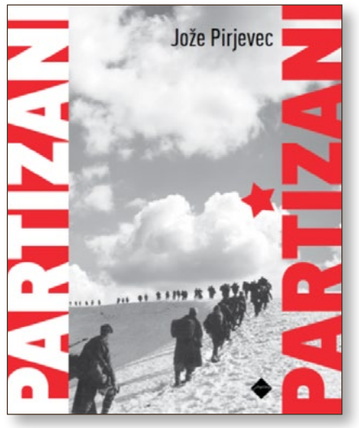
Source: MLEKUŽ, Jernej. The renaissance of sausage: the role of Kranjska sausage in the contemporary process of reconstructing the Slovenian nation. Nations and nationalism: journal of the association for the study of ethnicity and nationalism, ISSN 1354-5078, 2020, vol. 26, iss. 2, pp. 407-423, doi: 10.1111/nana.12572. [COBISS.SI-ID 46141741].
Hyperlink: https://onlinelibrary.wiley.com/doi/abs/10.1111/nana.12572

Dr. Jože Pirjevec

The Partisans

The monograph on the partisan struggle in Yugoslavia (1941-1945) is the result of research done by Jože Pirjevec in the frame of the ARRS program "Slovenia and The Mediterranean" P6-0272, which lasted more than five years and touches on the author's expertise in contemporary history. He has delved into Slovenian, Croatian, Serbian, and with the help of the A. von Humboldt-Stiftung, German sources related to WWII, also conducting research in British archives, primarily in The National Archive, London, and the Winston Churchill Archive, Cambridge. In addition to this material the author studied rare Russian publications collected in Moscow and the copious American documents generously given to the author by his late colleague Dušan Biber. In the Archive of Yugoslavia in Belgrade, among other papers the author discovered the unpublished war memoirs written by Josip Broz Tito which enriched his knowledge on the liberation movement in dismembered Yugoslavia during WWII. Based on these documents and rich national and international literature, a story unfolded which encompassed the complex and tragic history of the Yugoslav people in the years 1941-1945 with a special reference to the Slovenian Liberation Front. The author confronted this task – made all the more difficult due to the various nations and theatres of war involved, the numerous armed forces present on the ground, and the opposite ideologies inherent among the struggling parties – without an aprioristic ideological attitude, despite his acknowledgement of the importance of the partisan struggle in Slovenian history and the history of other South Slav peoples. He does not deny the epic dimension of this experience, nor does he ignore its dark side.

Since the time is ripe for an appraisal of the partisan movement that is neither apologetic nor rejective, he located it in the vast framework of Europe and the Mediterranean dominated by the Axis powers and by the Anglo-American and Soviet allies. The internal conflict present among the German, Italian and Bulgarian aggressors, and the Western and Eastern antifascist forces decisively conditioned military and political events in occupied Yugoslavia. It is not an exaggeration to say that the "Cold War" between the Anglo-Americans and the Soviets started in the Trieste region and Carinthia in May 1945 and has had a decisive impact on the drawing of Slovenia's borders both with Italy and Austria.



Dr. Jože Pirjevec, Science and Research Centre Koper (joze.pirjevec@zrs-kp.si)

Source: PIRJEVEC, JOŽE. PARTIZANI. Ljubljana : Cankarjeva založba, 2020.
Hyperlink: https://www.mladinska-knjiga.si/knjige/stvarna-literatura/partizani

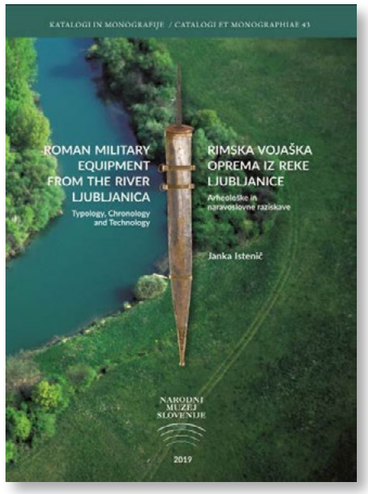
Dr. Janka Istenič

Roman military equipment from the Ljubljanica River: typology, chronology and technology

The book presents 79 Roman military equipment items (weapons, metal parts of military belts, military decorations, and tools) from the Ljubljanica River (central Slovenia), dating from the Republican period to the end of the Principate. Most of the artefacts are complete and very well preserved, which offers excellent insight into the manner of their construction and production.

In addition to the extensive catalogue (the pieces are presented in drawings, numerous colour photographs, and detailed descriptions), the monograph includes results of an in-depth research in their typology, chronology and special distribution in the riverbed, as well as the systematic examination of the elemental composition of the non-ferrous metals. For 54 items, it has been possible to establish a relatively narrow dating, mostly to the Middle and Late Augustan periods. The available evidence suggests that the chronological and spatial distribution of Roman military equipment in the riverbed of the Ljubljanica River was mainly determined by two factors: firstly, the great importance of traffic along the Ljubljanica for provisioning the Roman army in the Late Republican and particularly in the Augustan period, and secondly, the location of the eastern border of Cisalpine Gaul (Italy after 42 BC) at the characteristic bend of the Ljubljanica at Bevke. Both factors changed significantly roughly at the same time, at the end of the Augustan or the beginning of the Tiberian period.

The author presumes that the high numbers of Roman militaria in the river are mainly related to the activities of the army at harbours and control points along the river, as well as to religious rituals performed before crossing the boundary of Cisalpine Gaul (after 42 BC Italy). This boundary was presumably the limit of the cadastrated Roman land (ager limitatus) and is indicated by the boundary stone between the territories of the colonies Aquileia and Emona found at the bend of the Ljubljanica River east of Bevke; the author suggests that upon the foundation of the colony of Emona, the limit of ager limitatus became the boundary between the territories of that city and Aquileia. The military finds from the Ljubljanica River argue in favour of dating the foundation of the colony of Emona to the end of the Augustan period.



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Source: ISTENIČ, Janka, Roman military equipment from the river Ljubljanica: typology, chronology and technology = Rimska vojaška oprema iz reke Ljubljanice: arheološke in naravoslovne raziskave. Ljubljana: Narodni muzej Slovenije, 2019. 394 pp., illustr. Katalogi in monografije, 43.
Hyperlink: https://www.nms.si/si/files/default/muzej/zaposleni/Istenic/KIM43-uvodne.pdf

Dr. Marija Klobčar

Monograph: Listen to My Voice. Itinerant Singers in Slovenia

The monograph Listen to My Voice. Itinerant Singers in Slovenia discusses various groups of itinerant singers in Slovenia in the period spanning from the Middle Ages to the rise of the radio. It analyses their creativity and observes the changes in their social roles. Critically considering unknown or overlooked testimonies, the monograph gives a new insight not only on the song creativity but also on the society where it flourished. It looks at the carriers of chivalric culture, which brings to light new findings on the importance of Slovenian language and song creativity in the Middle Ages. Its analyses of communication channels during the rise of printed materials sheds light on the role of Slovenian lands within the broader European framework. Through the research of the itinerant fair singers, the phenomenon itself and the singers' activities, it examines a fairly unknown diverse group of intermediaries between the high culture and the culture of common people in Slovenia. Furthermore, it illuminates the historical background and social role of some narrative songs, broadsides, the development of newspaper information and the effect of the changing transport and communication channels on this kind of creativity. Looking at the folklorisation of songs sung by itinerant singers, the monograph changes the understanding of creators of folk traditions: the folk characteristics express not only the culture of the rural population, but also a series of creative individuals from various social classes.

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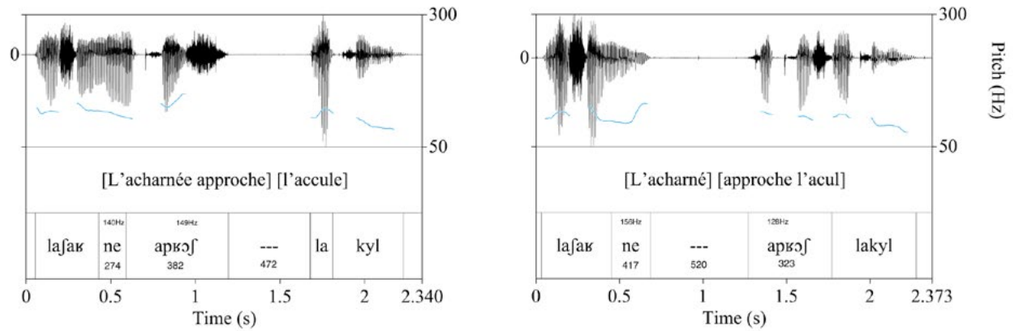
Source: KLOBČAR, Marija. Poslušajte štimo mojo: potujoči pevci na Slovenskem. 1. izd. Ljubljana: ZRC SAZU, Založba ZRC, 2020. 353 pp., illustr., note. Zbirka Folkloristika, 9. ISBN 978-961-05-0268-5. ISSN 2232-3791. [COBISS.SI-ID 304331776
Hyperlink: https://gni.zrc-sazu.si/sl/publikacije/poslusajte-stimo-mojo#v

Natural sciences | Engineering sciences | Medical sciences | Biotechnical sciences | Social sciences | Humanities | Interdisciplinary research

Dr. Artur Stepanov

The role of working memory in children's ability for prosodic discrimination

Previous research has shown that children are sensitive to prosodic properties that signal different syntactic structures of otherwise similarly sounding sentences in an unknown language. In this study, we explore the role of working memory (the part of the brain that deals with short-term storage and processing of information in real time) that children deploy for the task of discriminating between two similarly sounding sentences in an unknown language (French). We tested 70 nine-year-old monolingual and multilingual Slovenian children in primary schools and school centers in Nova Gorica and North Littoral regions. The tested children showed considerable success in the listening discrimination task. The same children were also tested on the standard working memory tasks including forward and backward digit span and non-word repetition tasks. The results of our study show that both parts of the working memory, namely, the short-term storage component as well as the (audio) information processing component are likely to be involved in perception of prosodic properties of sentences in an unknown language.

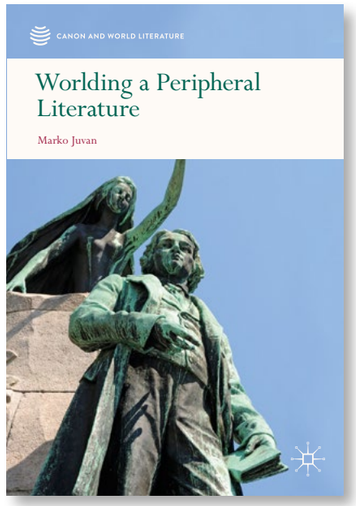


Dr. Arthur Stepanov, University of Nova Gorica (arthur.stepanov@ung.si)

Source: STEPANOV, Arthur, KODRIČ, Karmen Brina, STATEVA, Penka. The role of working memory in children's ability for prosodic discrimination. PloS one. Mar. 2020, vol. 15, no. 3, pp. 1-16, illustr. ISSN 1932-6203.
Hyperlink: https://doi.org/10.1371/journal.pone.0229857

Dr. Marko Juvan

Worlding a peripheral literature



Taking the case of the Slovenian "national poet" Prešeren as a starting point, Juvan's book deals with the role of world literature in relation to national literatures, especially peripheral ones. The presence of literary works in world circulation and their world canonization depend on their origin, language, demand on the global market, and the international position of domestic literature. Cultural capital is unequally distributed in the world literary system, which is itself located in an unequal world system of capitalism. National literatures, such as Slovenian, confirmed their linguistic and cultural individuality through the process of worlding, i.e., by trying to find their place in the international literary world, where supposedly universal aesthetic criteria prevail. This monograph combines analyses of the literary world system and canonization, translation studies, and research on European cultural nationalism. It attempts to explain why, in systemically marginal literatures, the internal perspective of worlding is not confirmed by the external perspective of the centres. Using the Slovenian "national poet" Prešeren as an example, the author discusses the canonical function of world literature in the assertion of national literatures, especially peripheral ones. In the international context, the book represents a "corrective to mainstream world literature studies" (Domínguez).

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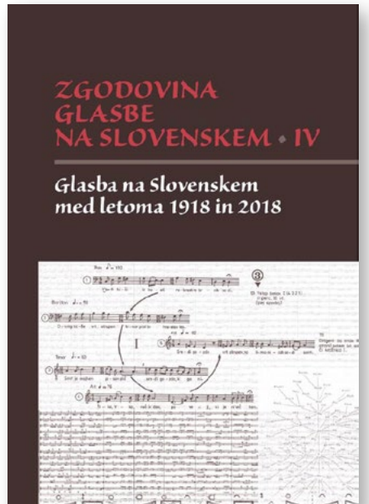
Source: JUVAN, Marko. Worlding a peripheral literature, (Canon and world literature). Singapore: Palgrave Macmillan, cop. 2019. VII, 291 pp.
Hyperlink: https://link.springer.com/book/10.1007%2F978-981-32-9405-9

Natural sciences | Engineering sciences | Medical sciences | Biotechnical sciences | Social sciences | Humanities | Interdisciplinary research

Dr. Gregor Pompe

Monograph: Zgodovina glasbe na Slovenskem (History of music in Slovenia)

The monograph outlines a historical overview of music in Slovenia in the 20th century, or better, in the hundred years between 1918 and 2018. Individual chapters are designed chronologically. Author and his collaborators discuss various compositional techniques, stylistic periods and broader phenomena related to the history of Slovenian music. The historical "path" thus leads us from early musical modernism, through a commitment to the New music (Expressionism, New Objectivity, neoclassicism, neo-Baroque, dodecaphony), specific situation related to the difficult war and post-war political agenda, post-war breakthrough of modernism and its cooling in postmodernism to the present moment, which, according to the author, is marked primarily by the general pluralism of ideas, genres and approaches. In methodological terms, history is primarily conceived as the history of musical works, but the author is never completely phenomenologically "pure", as he often connects the treatment of individual works with other historical or social issues, thus drawing a broader historical fresco. The work of Gregor Pompe is the only one so far that brings a picture of national history derived from musical works, i.e. serious music, from the end of the First World War to the present day. In the discussion, he tackles many topics for the first time and gives an aesthetic opinion about the latest music, which has not yet reached the distance of time. This book will certainly represent the basis for many further investigations of Slovenian contemporary music.

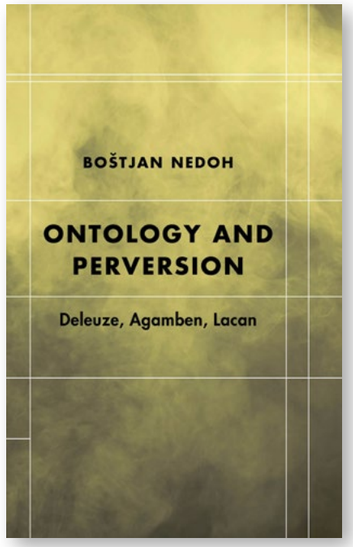


Dr. Gregor Pompe, University of Ljubljana, Faculty of Arts (gregor.pompe@ff.uni-lj.si)

Source: POMPE, Gregor. Zgodovina glasbe na Slovenskem. 4, Glasba na Slovenskem med letoma 1918 in 2018. 1. izd. Ljubljana: Znanstvena založba Filozofske fakultete Univerze: Založba ZRC, 2019. XXI, 680 pp.
Hyperlink: https://zalozba.zrc-sazu.si/sl/publikacije/zgodovina-glasbe-na-slovenskem-iv#v

Dr. Boštjan Nedoh

Ontology and perversion



This book examines the philosophical and political relevance of perversion in the works of three key representatives of contemporary philosophy and psychoanalysis: Gilles Deleuze, Giorgio Agamben and Jacques Lacan. Perversion is often understood simply in terms of cultural or sexual phenomena, which is why it may seem unworthy of serious philosophical investigation. By contrast, this book places perversion at the heart of philosophical and political issues in the works Deleuze, Agamben and Lacan. It examines the relevance of their discussions of perversion for their respective critical ontological projects. By tracing the differences between the understandings of perversion by these thinkers. The book finally draws lines of delimitation between the vitalist and structuralist or psychoanalytic philosophical positions in contemporary philosophy.

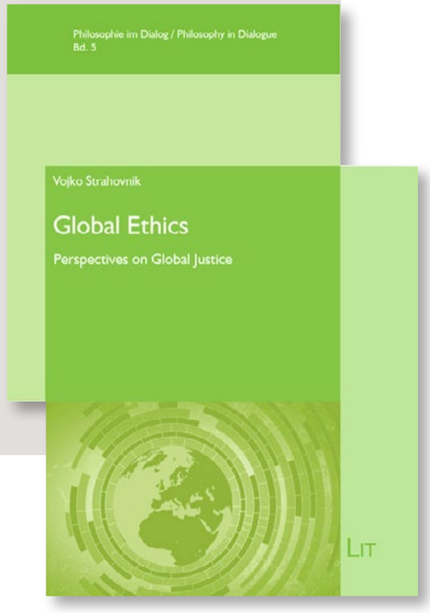
Dr. Boštjan Nedoh, Research Centre of Slovenian Academy of Sciences and Arts (bnedoh@zrc-sazu.si)

Source: NEDOH, Boštjan. Ontology and perversion : Deleuze, Agamben, Lacan, (Futures of the archive). Lanham: Rowman & Littlefield International, cop. 2019. IX, 204 str. ISBN 978-1-78660-551-1.
Hyperlink: https://www.amazon.com/Ontology-Perversion-Deleuze-Agamben-Futures/dp/1786605511

Dr. Vojko Strahovnik

Global ethics: Perspectives on Global Justice

Justice is one of the most pressing ethical challenges facing humanity on the global scale. A holistic approach to the dimensions of global justice is developed. Among other things, the author discusses the definition of global ethics and global justice, the dimensions of justice and the issue of universal standards of justice, moral disagreements and moral dialogue, the issue of agents of global justice, status justice and membership, restorative justice in historical and community contexts, the role of emotions and reactive attitudes (shame, guilt) in reconciliation processes, intercultural and interreligious dialogue, the role of intellectual humility and epistemic justice, and a culture of fear and religious (in)tolerance. The main unifying theme of all these discussions is the focus on justice as one of the most important ethical challenges of the modern world. It also introduces a special discussion on epistemic (in)justice, and incorporates it into traditional discussions on justice, thus expanding the field of discussions in an important way.



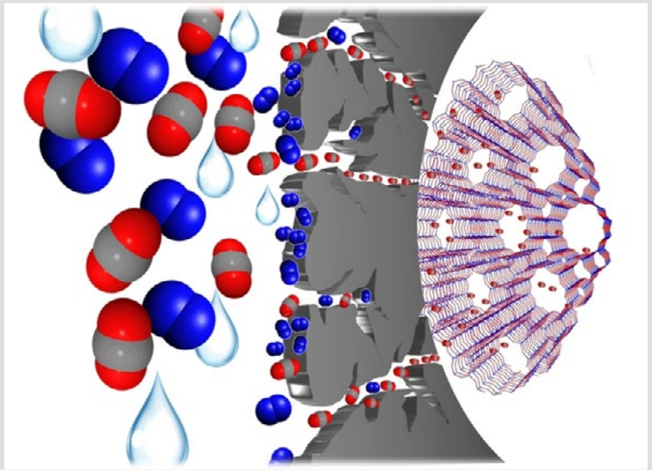
Dr. Vojko Strahovnik, University of Ljubljana, Faculty of Theology (vojko.strahovnik@gmail.com)

Source: STRAHOVNIK, Vojko. Global ethics: Perspectives on Global Justice, (Philosophy in dialogue, vol. 5). Zürich; Wien: Lit, 2019. 122 pp.
Hyperlink: https://www.amazon.com/Global-Ethics/dp/3643911246

Dr. Sebastijan Kovačič, dr. Matjaž Mazaj

Zeolite nanocrystals embedded in microcellular carbon foam as a high-performance co2 capture adsorbent with energy-saving regeneration properties

Until finding a way to curb our reliance on fossil fuels, materials for CO2 capture will be an essential part of a holistic approach toward a sustainable energy future. The present study describes the development an advanced solid-adsorbent for CO2 capture, the so-called hierarchically porous zeolite@carbon nanocomposite foam. The innovative, hierarchically porous zeolite@carbon nanocomposite adsorbent offers extraordinary improvement in the uptake (5 mmol·g-1), selectivity, durability (70% of the whole adsorption capacity maintained through 30 adsorption-desorption cycles) and regeneration, which were tested under real-life conditions and compared to available state-of-the-art materials. Impressive is the amount of energy consumed during the regeneration of our zeolite@carbon nanocomposite adsorbent, which could drop down to 12 kWh versus 50,000 or 840 kWh for the available benchmark adsorbents.



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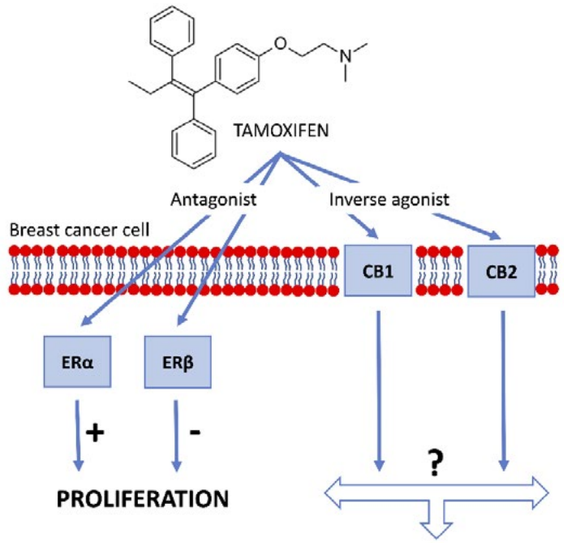
Source: M. Mazaj, M. Bjelica, E. Žagar, N. Zabukovec Logar, S. Kovačič, Zeolite Nanocrystals embedded in microcellular carbon foam as a high-performance CO2 capture adsorbent with energy-saving regeneration properties. ChemSusChem, 2020, 13, 2089-2097.
Hyperlink: https://onlinelibrary.wiley.com/doi/abs/10.1002/mame.201800426

Dr. Simona Borštnar, dr. Nataša Debeljak

Cannabinoids and hormone receptor-positive breast cancer treatment

Breast cancer is globally (and in Slovenia) the most common form of cancer in women. It represents 20.4 % of all cancers in this sex. About 70-80 % of breast cancers express hormone receptors (ER, PR) and are consequently hormone dependent. Endogenous cannabinoids together with cannabinoid receptors (CB1 and CB2) form the basis of the endocannabinoid system. The clinical use of cannabinoids in oncology is currently limited to palliative care. Although interactions of cannabinoids and endocannabinoid system with sex hormones are known, the impact of cannabinoids on breast cancer remains unclear.
We summarized the scientific literature on the effect of cannabinoids on hormone-dependent breast cancer. We presented all known and potential interactions between cannabinoids and different treatment approaches for hormone-depended breast cancer. Clinical studies to investigate this area have not yet been published. This achievement is the result of collaboration between two program groups and confirms the importance of interdisciplinary integration.



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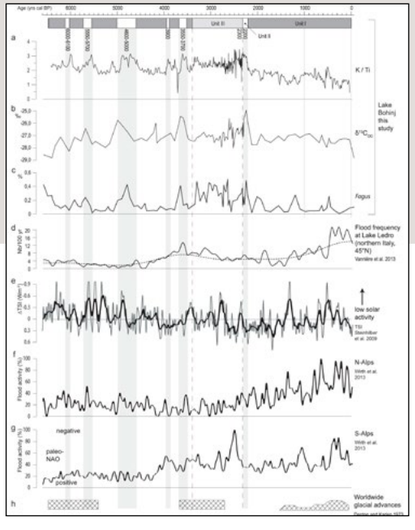
Dr. Nataša Debeljak, University of Ljubljana, Medical Faculty (natasa.debeljak@mf.uni-lj.si)

Source: DOBOVIŠEK Luka, KRSTANOVIĆ Fran, BORŠTNAR Simona, DEBELJAK Nataša. Cannabinoids and hormone receptor - positive breast cancer treatment. Cancers, 2020, vol. 12, iss. 3, pp. 1-12.
Hyperlink: https://www.mdpi.com/2072-6694/12/3/525

Dr. Maja Andrič, dr. Andrej Šmuc

6600 years of human and climate impacts on lake-catchment and vegetation in the Julian Alps (Lake Bohinj, Slovenia)

The present influence of man upon nature and natural processes is extremely great, but how was it in the remote past? We sought the answer to this question in the sediments of Lake Bohinj, which record environmental changes in the region for more than 10,000 years. Based on geochemical, geological and palynological analyses, we have created a detailed reconstruction of the former environment of Bohinj for the last 6600 years. We have shown that the human impact on the environment (agriculture, grazing, mining) since Bronze Age was extremely large, sometimes even catastrophic. The vegetation and hydrology of the lake were also strongly influenced by seismic activities and large climate variations. For example, in wetter periods, water flowed into Lake Bohinj not only from the direction of Savica (as it does today), but also from the eastern part, i.e. from the direction of Stara Fužina. With the present research, we reveal a glimpse of the fragile balance between natural and human influences that condition the development of today's landscape, and provide guidelines that will help preserve the natural and cultural heritage in the future.



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Dr. Andrej Šmuc, University of Ljubljana, Faculty of Natural Sciences and Engineering (andrej.smuc@ntf.uni-lj.si)

Source: ANDRIČ, Maja, SABATIER, Pierre, RAPUC, William, OGRINC, Nives, DOLENEC, Matej, ARNAUD, Fabien, GRAFENSTEIN, Ulrich von, ŠMUC, Andrej. 2020. 6600 years of human and climate impacts on lake-catchment and vegetation in the Julian Alps (Lake Bohinj, Slovenia). Quaternary science reviews, ISSN 0277-3791, 2020, vol. 227.
Hyperlink: https://www.sciencedirect.com/science/article/pii/S0277379119306134?via%3Dihub

SLOVENIAN RESEARCH AGENCY

	Slovenian Research Agency
Abbreviated name:	ARRS
Year of foundation:	2004
Core activity:	Performance of professional, development and executive tasks relating to the implementation of the Resolution on Research and Innovation Strategy of Slovenia 2011-2020 and other tasks with statutory duties in public interest in order to ensure permanent, professional and independent decision-making on the selection of programmes and projects financed from the national budget.
Number of employees as of 1 January 2020 in accordance with the staffing plan:	49
Funds received from the national budget for scientific-research activities in the 2020 financial year:	EUR 206,7 mil.
Basic documents:	Research and Development Act (Official Gazette of the Republic of Slovenia, nos. 22/06 – official consolidated text, 61/06 – ZDru-1, 112/07, 9/11, 57/12-ZPOP-1A and 21/18-ZNOrg) Decision establishing the Slovenian Research Agency (Official gazette of the Republic of Slovenia, nos. 123/03 and 105/10) Resolution on Research and Innovation Strategy of Slovenia 2011-2020 (Official gazette of the Republic of Slovenia, no. 43/11)
Website:	http://www.arrs.si/en/