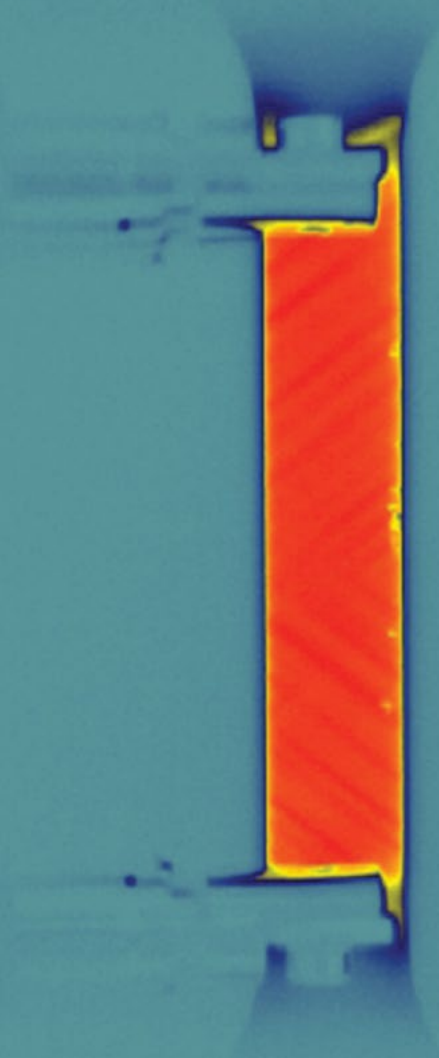


# ANNUAL REPORT 2018



**arrs**

SLOVENIAN RESEARCH AGENCY

## Introduction



In 2018, efforts to significantly increase funding for science in Slovenia took place at different levels. Researchers, universities and research institutes made their voices heard, and the political and implementation level became aware that the funding for science is significantly lagging behind the strategic goals set in the National Research and Innovation Strategy of Slovenia in force until 2020.

Consequently, in 2018, the work program and the financial plan of the Slovenian Research Agency (hereinafter: Agency) were upgraded with two supplementary budgets, which also meant an increase of funds in comparison to the Agency's foreseen budget. The Agency followed the guidelines of the ARRS operation and development strategy by 2020, namely: (I) implementation of activities in accordance with the

highest standards of quality, legal bases, decision on the establishment and national strategic documents in force, (ii) transparent operation and responsiveness, (iii) optimization of instruments and development of pilot instruments, (IV) monitoring of the effects of the implementation of activities, (V) integration in international environment and comparability, (VI) transition to purely electronic services, and (VII) open communication with the public and the promotion of science.

With the increase in the funds for science in the state budget in 2018, ARRS was able to increase the scope of approved research projects, significantly improve the quality of the program groups, enable researchers throughout Slovenia to access the most prestigious journals and gradually implement more visible activities in the field of open access.

The latter is particularly important as ARRS, through Science Europe, joined the national funders of research activities who, under Coalition S, endorsed a joint plan with the European Commission called Plan S (Plan S – Accelerating the transition to full and immediate Open Access to scientific publications). ARRS, as well as most sister agencies, joined the coalition with the goal to obtain implementation support for politically clearly articulated decisions of Member States regarding open access. Slovenia put in place the national strategy for open access to publications and research data in 2015, but similar to other countries, its implementation practices are only being established. As regards international activities in 2018, we want to highlight the signing of the CEUS agreement in Vienna in October 2018 during the Austrian presidency of the EU, the intensive preparation for cooperation as

*“ The Agency would like to pay special attention to the circulation of knowledge and the strengthening of research area. ”*

a leading agency with Switzerland and active participation in the Science Europe working group to establish a multilateral leading agency mechanism.

The organization and realization of the ARRS Day: Supporting Excellence under the auspices of the President of the Republic publicly and substantively captured the activities of the Agency, and led to public discussions on the evaluation system in cooperation with the Slovenian Academy of Sciences and Arts and the competent ministry. The Agency's expectations are focused on multiannual predictability of funding, recruitment of new employees for operations that are stable and adhere to the highest standards of quality, and the implementation contribution in the event of legal changes in institutional financing. The Agency would also like to pay special attention to the circulation of knowledge and the

strengthening of research area.

In line with expectations, we note that the staff of the Agency as the central institution in the fields of evaluation, financing and monitoring of the research activity must have appropriate qualifications. The minimum redundancy with regard to personnel and implementation is a precondition for reducing high risks the Agency is currently exposed to. The expert and administrative body of 49 associates employed by the Agency participates in highly-computerized processes and also coordinates 90 members of permanent professional bodies and more than 800 foreign evaluators each year with one very ambitious goal: to provide high quality and reliable funding for research activities, comparable to international standards. Increased funding, continuous improvement of processes, implementation of pilot instruments and the ever stronger internation-

al cooperation require a reliable platform of motivated individuals. In the last year of my mandate as a director, I would like to thank all my colleagues for their effort, but also to the vast majority of colleagues for their responsiveness and openness to changes and improvements that are a constant element in the operation of such an agency.

*Prof. Dr. József Györkös,  
Director*

## Moving away from quantitative criteria generates a number of new challenges for the Agency



Mankind's first modest attempt to understand the world was philosophy. It was the origin of disciplines (now referred to as sciences), whereby the division into so-called empirical sciences – which are currently on the rise, self-assured, more creative than critical and often unfoundedly portrayed as the saviours of human reason and the driving force of any progress – and humanities deepened, although it is humanities that give us the knowledge to be able to give meaning to our existence. This includes the motivation to understand the world we live in, and the awareness of the importance of science in this regard. It is obvious this requires the knowledge on how the universe works and what it means to be alive, conscious, human. "Medicine, law, business, engineering, these are all noble pursuits, and necessary to sustain life. But poetry, beauty, romance, love, these are what

we stay alive for", as we are reminded by the famous quote from The Dead Poet Society. C. P. Snow (On the Two Cultures, 1956) already said that sciences and humanities must go hand in hand if we are to understand the world (completely). Are humanities really treated as an equal partner in this endeavour? I will leave this to your judgement.

My appointment to the Scientific Council of the Slovenian Research Agency (ZSA) to represent the field of humanities has enabled me to work closely with the representatives of other sciences in the ZSA, on the one hand, and the representatives of all humanistic disciplines (as classified by ARRS) in the scientific research councils (ZSV), on the other. Successful and coordinated functioning of the ZSA requires the understanding of the specifics of all scientific disciplines – it is not only necessary to be aware of the differences between

them, their acceptance must be a self-evident characteristic of human thinking, creativity and, therefore, scientific activity. It is much easier to adopt rules that support and enable scientific excellence, if natural scientists, engineers, social scientists and humanists reach a mutual understanding and common ground. Although we all know how strongly science is determined by language, this is often overlooked in our scientific and research community. It is essential that we develop science and art in Slovene and for the Slovenian environment. If we do that in foreign languages only, this will inevitably lead to the extinction of Slovene as a language of science and research. Researching the Slovene language as a national language and the language of national identity and scientific research in the field of natural and cultural heritage should be among research and national spend-

ing priorities, and the same goes for research in the fields in which Slovenian science successfully integrates into global flows, such as health, infrastructure and artificial intelligence, to mention only three that significantly improve the lives of individuals and society. The importance of humanities is also highlighted by remarkable achievements in artificial intelligence, since it is obvious that *differentia specifica* of being human is not reason.

In ZSV, I contribute to tackling the challenges faced by the humanities and participate in the harmonization of proposals put forward by representatives of individual professions. In ZSA, I represent the interests of science and thereby the interests of linguistic, literary, archaeological, ethnological, (art) historical, musical and spiritual heritage. Before I started my mandate in the ZSA the task did not seem too arduous, consider-

ing we all strive for scientific excellence, but the reality is different. For example, moving away from basing scientific excellence evaluations on quantitative criteria, which now only serve as entry thresholds and reference points in the qualitative evaluation of project and program proposals, is not as straightforward as it seems, as it generates a number of new challenges for the Agency. In its current composition, ZSA will not be able to solve all the problems of individual disciplines and researchers by the end of its mandate. Establishing a system demonstrating that the rules that are conducive to scientific excellence at the given moment are important and necessary, and establishing awareness that similar to constant changes in society and science, evaluations and rules are part of constant processes employed by ARRS to promote excellence in science, would already constitute a

great success. The responsibility of individuals, i.e. excellent scientists, who actively contribute to these processes on the basis of in-depth reflection and their international experience, is crucial.

I believe that in this mandate, the ARRS management board and ZSA have significantly contributed to changes that will, through reliable financing, bring about the independence of science, which can only be achieved by engaging individuals whose livelihood does not depend on constantly submitting applications for new projects, and will enable pilot calls for applications to finance research providing answers to constant challenges faced by the society in our demanding and everchanging world.

*Prof. Dr. Mihaela Koletnik,  
Member of the ZSA for Humanities*

## Annual report 2018

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### Cover picture

Assist. Prof. Dr. Jaka Tušek:  
*Temperature response of elastocaloric material  
from Ni-Ti alloy during tensile loading recorded  
with a thermographic camera.*

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## 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 2014. The term of current members ends in 2019.

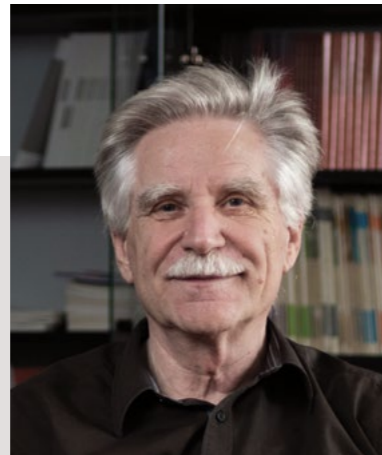


**Prof. Dr. Rado Bohinc**  
*President*

University of Ljubljana,  
Faculty of Social Sciences



**Prof. Dr. Polona Domadenik**  
*Vice president*  
University of Ljubljana,  
Faculty of Economics



**Mag. Franci Pivec**  
Institute of information science,  
Maribor (retired)



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Faculty of mechanical engineering



**Prof. Dr. Igor Muševič**  
University of Ljubljana,  
Faculty of Mathematics and physics



**Assist. Prof. Dr. Tomaž Savšek**  
TPV d. d.

## 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 2020.



President

**Prof. Dr. Marko Topič**  
*engineering sciences*  
University of Ljubljana,  
Faculty of Electrical Engineering



**Prof. Dr. Roman Jerala**  
*natural sciences*  
National Institute of Chemistry



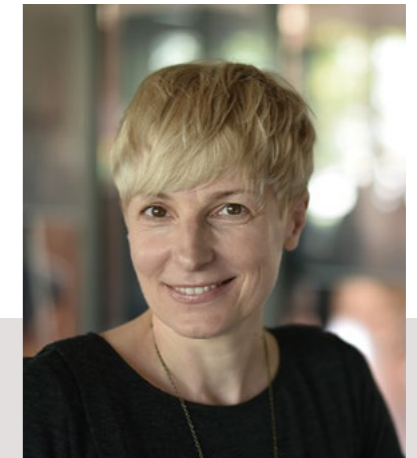
**Prof. Dr. Nina Zidar**  
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Faculty of Medicine



**Prof. Dr. Tatjana Avšič Županc**  
*biotechnical sciences*  
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Faculty of Medicine



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*social sciences*  
Institute for Ethnic Studies



**Prof. Dr. Mihaela Koletnik**  
*humanities*  
University of Maribor,  
Faculty of Arts

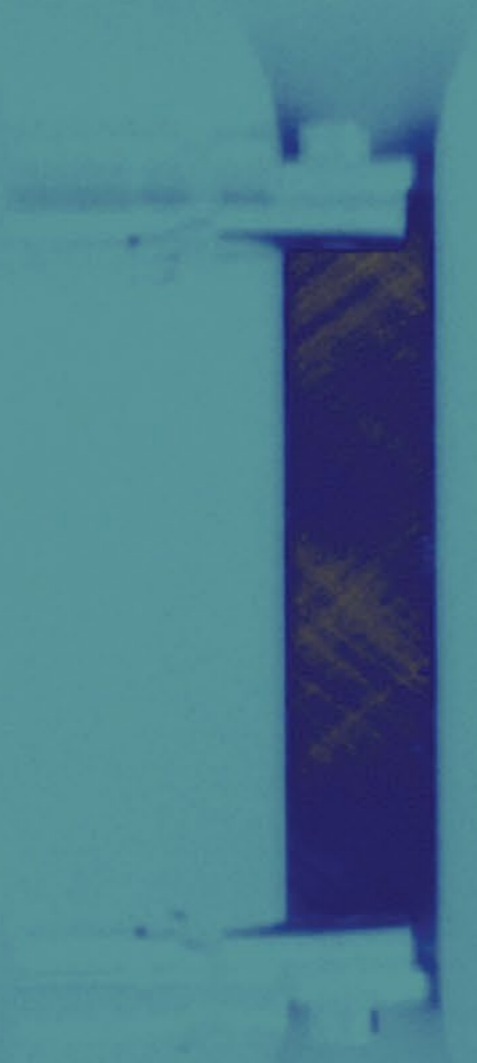
# ARRS funding mechanisms

	Doctoral level up to doctoral degree	Post-doctoral level up to 3 years after attaining a doctoral degree	Post-doctoral level until 5 years after attaining a doctoral degree	Young doctor up to 10 years after defending the first doctorate	Established researcher
				Research programme <i>Public tender and call</i>	Research programme <i>Public tender and call</i>
		Post-doctoral research project (basic or applied) <i>Public call for (co-)financing research projects</i>	Research project (basic or applied) <i>Public call for (co-)financing research projects</i>	Research project (basic or applied) <i>Public call for (co-)financing research projects</i>	Research project (basic or applied) <i>Public call for (co-)financing research projects</i>
Young researchers <i>Public tender MR and MR+ (calls from research organizations)</i>				Young mentor <i>Public tender MR</i>	Mentor MR and MR+ <i>Public tender MR</i>
	The ERC complementary scheme <i>Public tender for (co-)financing adapted research projects</i>	The ERC complementary scheme <i>Public tender for (co-)financing adapted research projects</i>	The ERC complementary scheme <i>Public tender for (co-)financing adapted research projects</i>	The ERC complementary scheme <i>Public tender for (co-)financing adapted research projects</i>	The ERC complementary scheme <i>Public tender for (co-)financing adapted research projects</i>
	Visits to ERC Grantees <i>Public tender</i>	Visits to ERC Grantees <i>Public tender</i>	Visits to ERC Grantees <i>Public tender</i>	Visits to ERC Grantees <i>Public tender</i>	Visits to ERC Grantees <i>Public tender</i>
				The lead agency scheme <i>Public tenders of partner LA agencies</i>	The lead agency scheme <i>Public tenders of partner LA agencies</i>
MSCA Seal of Excellence <i>Public call</i>	MSCA Seal of Excellence <i>Public call</i>	MSCA Seal of Excellence <i>Public call</i>	MSCA Seal of Excellence <i>Public call</i>	MSCA Seal of Excellence <i>Public call</i>	MSCA Seal of Excellence <i>Public call</i>
	Reimbursement of expenses – H2020 <i>Public tender</i>	Reimbursement of expenses – H2020 <i>Public tender</i>	Reimbursement of expenses – H2020 <i>Public tender</i>	Reimbursement of expenses – H2020 <i>Public tender</i>	Reimbursement of expenses – H2020 <i>Public tender</i>
				JPI Urban Europe <i>International tender</i>	JPI Urban Europe <i>International tender</i>
					NORFACE <i>International tender</i>
	International bilateral projects <i>Public tenders for individual countries</i>	International bilateral projects <i>Public tenders for individual countries</i>	International bilateral projects <i>Public tenders for individual countries</i>	International bilateral projects <i>Public tenders for individual countries</i>	International bilateral projects <i>Public tenders for individual countries</i>
COST actions	COST actions	COST actions	COST actions	COST actions	COST actions

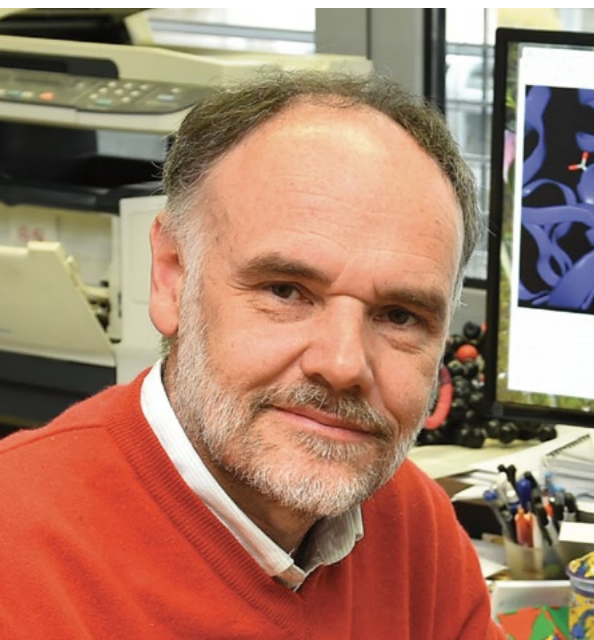
- Research programmes
- Research projects
- Young Researchers
- International cooperation

Information on other available mechanisms available at: <http://www.rrs.gov.si/sl/razpisi/>

IN THE SPOTLIGHT







# Molecular machines

based on coiled-coil

**Prof. Dr. Roman Jerala**  
National Institute of Chemistry



*Prof. Dr Roman Jerala received funds from the European Research Council for established researchers (ERC Advanced Grant). In the framework of the five-year project, the group will develop the principle of preparing artificial proteins based on modular coiled-coil (CCPO).*

***Your opus of successful research is remarkable, from the research of molecular defence mechanisms against viral and bacterial infections, to the discovery of a new manner of molecular identification of pathogens with the immune system. What leads you to tackle such crucial topics?***

Curiosity is the main guiding principle. We try to select topics in which we believe we have an advantage over others, that is those in which we think we are original, as our financial means make it difficult for us to compete with others, who are better in this respect. This is why I like to choose topics which are not immediately obvious.

***What is the sure way to become a successful researcher, a successful scientist?***

The most important element is hard work. All the successful researchers I know invest a lot of effort into their work. For us, this is not an ordinary nine-to-five job, but a mission, a lifestyle and I enjoy it. I also try to select co-workers and students who are motivated and driven by an internal need and satisfaction. Knowledge and prior education are of course also important. I can say that researchers, at least those of us who conduct experiments, are some sort of artisans at a higher level. In the end, it turns out that the thinking part represents only 10%, and everything else is experimental work. Years of experience help you select the direction which is worth pursuing. I am so fortunate to be able to mostly select research topics by myself. As usually, I submit them to reviewers and they assess whether they could be eligible for financing.

***Given all this, it comes as no surprise that you became the recipient of ERC Advanced Grant. This is the first Slovenian ERC project in the field of life sciences and chemistry. Could you tell us more about the project?***

I am greatly satisfied in getting this project, which was not easy. Today, I can perhaps even better appreciate what this means. When I attend lectures at foreign universities, I see that all the universities like to say how many ERC projects they have and which lecturers obtained them. This is a particularly welcome source of financial support which allows me to develop the matter in the desired direction. The project originates in 2009, when we had the iGEM-project of students from the field of synthetic biology. It was prepared for the competition at the Massachusetts Institute of Technology. At that time, the starting

point was, as I suggested, coiled-coil, i.e. structures in which two coils are folded together, one always paired with the other. The idea was to try to make two-dimensional nets or shapes. The then project was not very successful, but I thought that it had great potential. My idea was to make polyhedrons of some sort, shapes like a tetrahedron or a pyramid. Such a shape consists of just one polypeptide chain. In the beginning of 2013, I expected that it would not work, but I thought I would give it a try. And it did work. We published it in Nature Chemical Biology and it received a lot of attention. This is the basis of the current ERC project and on these grounds we can prepare prototypes of molecular machines, structures, which will be able to change the confirmation with regard to the external circumstances. This means that we have a type of cage, which can open, close and assemble. After all,

our muscles also consist of molecular machines. As soon as we enter several structures among which we can switch, we are dealing with some sort of machines, which carry out a type of work. The project has been designed quite ambitiously and I believe that we will succeed. One of major strengths of the ERC projects is that they give researchers a lot of freedom.

***What is the potential of this discovery for further work?***

These are new types of structures, which do not exist in nature. We indicated how far we can already get and such proteins can also be expressed in mammal cells. Our current work refers to the use of such structures for vaccinations. We will present the antigens for some viruses at the surface of these particles and we hope that this will trigger a stronger reaction. Another such use can be the

use of some sort of cages, into which we can pack things. Such cages can reach the final destination, such as cancer cells, where the compound from the cage can be released. It could also be an enzyme performing catalysis, for example degrading RNA and phospholipids, which are toxic, but within the cage, the cell is protected and able to perform its task. There are possibilities for various sensors and together with a Belgian group we are studying the potential of these cages for improving the sensors for detection of any agents or compounds.

**What made you decide to apply to the call? The reason I am asking this question is to encourage other researchers in the future, as so far Slovenia has not frequently been among the candidates for the ERC projects.**

This is a really generous project and this was the main motivation. It is one of the instruments available in Europe for the financing of fundamental research. All the others are aimed at applied research, which is neither very risky nor very ambitious. This is slightly misguided, as true innovation stems from smaller groups or individuals with ideas. If they want to develop this research, every scientist must strive to get funding for his or her research. National projects do help, but not to the extent to make this possible. It is important in terms of building reputation as both myself and National Institute of Chemistry can proudly claim this project. Everyone in Europe agrees that these projects are top notch, they are the most desirable projects in Europe.

**You received EUR 2.5 million for the period of five years. What does this bind you to?**

It binds me to perform good science. I must organize a team, I have the means to attract pre-doctoral researchers, post-doctoral students and allocate some of the funds to finance equipment. After all, our field requires a lot of funds for chemicals and reagents. The main characteristic of such projects is that they give you freedom and count on the researchers themselves to be motivated to develop something new. Interim reports need to be submitted to demonstrate the progress of the project, but not in the sense to state individual goals, as is the case with some other projects, where one is required to pass the checklists and have an EU official review them. Such pioneer researches do not always guarantee that a direction will prove to be successful. The main thing is to found the research on a good researcher who is able to find an alternative path in the case of problems and achieve the goal. I must say that I cannot know whether all of the matters which I presented in the project will succeed in the way which I envisioned. We have a good group of researchers and together we will achieve the results.

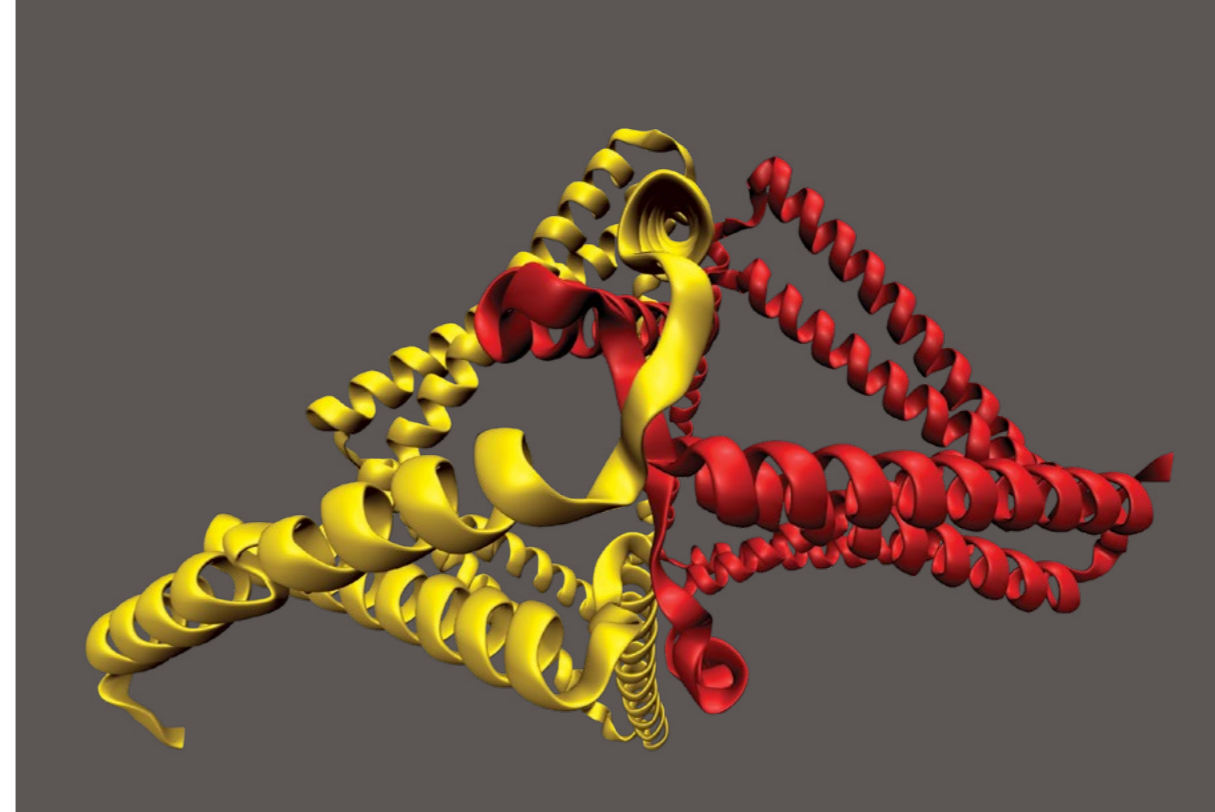
**Will you conduct all of the experiments in your laboratories or will any part of it require a more sophisticated research equipment? Do you have sufficient research equipment?**

The large majority will be carried out at our facilities while some of it will be carried out elsewhere, in cooperation with others. I mentioned the group in Belgium for the sensors. We will also cooperate with the group from Great Britain for the circularization of shapes, with the group in Germany and with the group for immunotherapy for vaccines from Switzerland. It

is good to have at least some equipment at our facilities, whenever possible, as it is quite a different thing when we are able to conduct experiments on our own. One of the demanding techniques is structural biology, determining the spatial structure of the artificially designed protein cages. The National Institute of Chemistry is currently in the process of purchasing a basic cryo-electron microscope, which will allow us to enter this field. We tried to collect the funds wherever possible. We will contribute a lot from our own funds, as well as from the ERC project. I expect that we will have the instrument by the end of the year and I have already started organizing a group of co-workers who will try to make maximum use of the instrument.

**We agreed at the beginning that the field of life sciences is extremely propulsive, with new findings evolving rapidly and the expectations being great. Given this point of view, is a five-year period a long or a short period of time?**

In a few years, when I look back at everything, I will say that it has passed quickly. I believe that this is quite a generous offer. Most of the projects are shorter, lasting three or four years, only programme groups have a six-year financing period. Five years is a period of time in which it is difficult to predict what will be of interest, while on the other hand it does allow one to undertake longer and riskier research. I am not required to provide results in a year or two and if nothing is published, there will be no problems. What counts is the end results, and this is its advantage. One does not have to go applying from one project to another and make sure that the results will be publishable.



**You educated several successful, young scientists, with whom you first reached excellent results at international competitions. This is hard work and a responsible task. How did you manage?**

It was either courage or chance. In 2006 I noticed in Nature a report on the students' meeting in which they stated research projects from synthetic biology and at the time, I did not know what it was. "Why not give it a try," I said to myself. If I knew then how much trouble and costs it would require, I doubt that I would have undertaken it. When we participated, the competition consisted of 30, perhaps 50 groups, while today there are over 300 participating. This was an important turning point in my professional life. Through this field, our group has made a name for itself within synthetic biology and everybody knows us. This helped me motivate and attract exceptional students, many of whom later continued their academic careers or entered the industry. I remember each pro-

ject with which we entered the competition, developed it and published it in distinguished publications. The competitions gave us a lot, but also required a lot of hard work, not just by me but also by students and mentors. In 2006, we did not know what synthetic biology was and today, it represents the main part of research in our laboratory.

**Such manner of development of young scientists in the scientific environment is not very frequent. Do you think that considering the future of the scientific work in Slovenia more attention should be given to the inflow of qualified staff renewal? Do you think that this would improve the competitiveness at the most prestigious calls such as the call for ERC projects?**

I believe so. Education and training in Slovenia are good, although looking at the second Bologna cycle, thorough changes will be required. If I observe the training of my students and that at the Caroline Institute, at

ETH, in Heidelberg or in Cambridge, I see that the second Bologna cycle is based on project work. Students carry out research and this is what brings them to our group. In the first year, there were only microbiologists who wanted to enter the laboratory and carry out research work, but did not have the opportunity to do so. In Slovenia, the second Bologna cycle is still based on lectures. There is not enough rotation and experience arising from experiments. Many students, at least those in life sciences, also decide to go abroad, and it is difficult to persuade them to return. They leave because they believe that the opportunities abroad are better, which is true, but I would not like them to leave thinking that Slovenia does not offer them work opportunities. I am sure that the Bologna study process should be reformed at least in the disciplines which include experimental work. This would require hard work and would be easier with the help of research institutes.

Ina Petric, [www.tromba.si](http://www.tromba.si)

# Superelastic Porous Structures for Efficient Elastocaloric Cooling

**Assist. Prof. Dr. Jaka Tušek**

University of Ljubljana, Faculty of Mechanical Engineering



Assistant professor Dr Jaka Tušek, a researcher at the Laboratory for Refrigeration and District Energy (LAHDE) at the Faculty of Mechanical Engineering, received funding from the European Research Council available to researchers who are at the beginning of an independent research career (ERC Starting grant 2018). He received EUR 1.4 million for the implementation of a project as part of which he will research the key elements of elastocaloric cooling technology.

**Dr Tušek, you are planning to develop an elastocaloric cooling device, which will significantly reduce environmental pollution in comparison with the current devices. Could you explain what this research is about?**

We intend to develop an alternative cooling technology, which could in the future replace the today's widely applicable vapour-compression cooling technology, which is almost two hundred years old. I believe this is the oldest electrically powered technology, which is still in daily use and currently has no serious alternative. Even though it has been further developed in the more than 200 years since its inception, is still relatively inefficient. For example, an average vapour-compression system can only operate at 20-percent efficiency in comparison with its theoretical maximum. It still uses polluting cooling agents.

The other part of the problem is the exponent increase in the energy consumption. At the current pace, it is estimated that by the end of the century, cooling will become the biggest electricity consumer. It is telling that there are currently approximately 1.2 billion air conditioners installed around the world, and that their number will increase to 4.5 billion in the next 25 years alone. All this, combined with the environmentally questionable cooling technology means that the future is bleak. This is why researchers all over the world are working intensively to find alternative cooling technologies.

Numerous alternative technologies already exist, such as thermoelectric cooling, which is used in higher end cooler bags, and absorption cooling, which is powered by waste heat and can be used in larger systems as district cooling. None of these technologies have proven to be an adequate alter-

native for the broadest use in cooling. In the past decades, several scientists observed the great potential of the caloric technologies with the use of ferroic solid materials. These include magnetocaloric cooling, electrocaloric cooling and elastocaloric cooling. The background of the caloric effect in these solids is the so-called solids phase of transformation in the material. When these materials are exposed to external stress, for example, the magnetic field in the case of magnetic cooling, or the electric field in the case of electrocaloric cooling, the solids phase of the transformation occurs and the material heats up. When the field is removed from this material, the reversal phase of the transformation occurs and the material cools below the temperature of the environment. This thermodynamic process can be used for cooling. Four years ago, the US department of energy carried out an extensive review

of all the possible alternative forms of cooling and elastocaloric cooling was singled out as the one with the biggest potential for the future.

**You claim that the elastocaloric technology has a great potential as an alternative to the current technology, which is almost 200 years old. How much "damage" has been caused by these technologies during this period and why have the scientists not questioned their consequences until recently?**

The scientists have always questioned the consequences, the only question is to what extent they were heard by the decision-makers. Focusing on the vapour-compression technology and its impacts on the environment, we can say that in the 1990s, when all the systems were based on ozone-depleting freons, we witnessed intensive ozone depletion. In the past

decades, these cooling agents were withdrawn from use and the ozone layer has recovered nicely. The other problem caused by these systems is the greenhouse effect. If we do not act, the forecasts show that the cooling systems alone will by the end of the century cause an increase of the average temperature on Earth by approximately a half degree Celsius. We are bound by the Paris Agreement to limit the warming of the atmosphere to 2 degrees in comparison with the pre-industrial period. The cooling agents alone are responsible for one fourth of the global warming.

**You are trying to develop an elastocaloric technology that you find most appropriate. How did you come across this idea?**

I have a PhD in magnetic cooling, which is one of the alternative technologies and shows great potential

for the future, but it is not without problems, as it is based on the use of rare earths, which is very uneconomical. Rare earths are very expensive. At the end of my PhD I found some scientific articles which indicated great temperature changes in the stretching and shrinking of elastocaloric materials. I immediately saw the connection with the technology of using the magnetocaloric effect for magnetic cooling and with the possibility to use this for the elastocaloric effect. I borrowed the function principle from magnetic cooling and I was the first to introduce it to the elastocaloric technology.

**You applied to the European call for ERC projects with your breakthrough idea and were already successful with your first try. However, due to the fierce competition, only 13% of the project applications were successful. Why did you decide to apply?**

The main thanks for the fact that I even got involved in this story goes to Jernej Kovač from the research department at the Faculty and especially to Tjaša Nabergoj from the University. Both of them, especially Tjaša – when I presented her the problem and the references, she refused to let go of the idea – strongly encouraged me to apply. Tjaša has a lot of experience and she thought that I could be successful. She believed that I fulfilled all of the ERC requirements. She offered me her help with the application and without it, I would probably not be successful.

#### **Could you describe the procedure and your experience with the presentation?**

The application consists of two parts, both of which are submitted together. The first part encompasses the CV, references and the idea of the project, while the second part comprises further description of the idea, methodology and the main goals. The panel members, who are top scientists from the field, first review the first part and then select the candidates for the second round. These candidates are invited to make a presentation in Brussels. I was given five minutes for the presentation, which is a great challenge for such a complex project. This was followed by 20 minutes of questions regarding the implementation and the probability of the execution. Various questions can be asked and the answers should be as credible as possible.

#### **What do you think was crucial for the success of your application?**

There were probably several factors, two of which I believe were essential. The first one was the fact that a few years ago I published an article in Na-

ture Energy, which currently has an impact factor of 46 and is the eighth most cited journal in the world. The article presented the concept of the use of elastocaloric technology. I presented the idea that the technology on which magnetic cooling is based was used in electrocaloric cooling. The very first prototype, which we presented in the journal, provided exceptional results. We also pointed to two challenges for the future, which need to be solved in order for the technology to ever enter the market. The first challenge is the lifespan of these materials, and the second one is the power system. We wish to develop a power system that will put stress on elastocaloric materials as efficiently as possible. The ERC application revolved around these two key challenges. I believe that the second key element in the assessment was the fact that after obtaining my PhD, I attended a post-doctoral study abroad, at the Technical University of Denmark. ERC requires the applicants to demonstrate a certain level of independence, even at the beginning of their research careers. This is not possible if you remain within the group of your doctoral mentor.

#### **You received EUR 1.4 million. What does this oblige you to do, which conditions and obligations do you have to fulfil?**

At first, I felt very honoured but now this also means a lot of work. I promised to research the key challenges of elastocaloric technology, which was already demonstrated. I will combine this in a functioning prototype and thus answer an important question of the project, namely, could elastocaloric technology represent the cooling technology of the future, will it first be useful in some niche applications and later in a broader spectre of cooling technologies.

#### **The project lasts for five years. How will you organize research in this period? Will you employ any additional researchers? If so, will you employ only researchers from the field of mechanical engineering or also from other technical disciplines?**

The project will employ six researchers and myself as the project leader. Three of them will be doctoral students and three post-doctoral researchers. Each of them will be employed for three years and will be responsible for one work package. The project is quite interdisciplinary within the field of mechanical engineering. It will employ process engineers, engineers from the field of mechanics of materials, constructors and metallurgists. The combination of various disciplines within mechanical engineering will allow us to address all of the challenges, which will result in a functioning prototype.

#### **Such research work probably also requires a lot of experiments. Where will they be carried out? Did you establish connections with any other partner?**

I am fortunate to work at Faculty of Mechanical Engineering, where we are very well equipped with regard to our project. In addition to the Laboratory for Refrigeration and District Energy, where the project will be carried out, we will closely cooperate with three other faculty laboratories. Some research will also be carried out at Jožef Stefan Institute and at the Institute of Metals and Technology. A subcontractor at the project will be an Italian company, which is the largest producer of these elastocaloric materials.

#### **What is the connection with the economy or industry, how open are they to your new ideas and to the ideas of scientists in general?**

European, but also global economies have shown great interest in our discoveries. We have established close ties with the companies which have an important role in the field cooling techniques. As an example, a few months ago, a director of an influential Italian company in the field of cooling techniques told me that they were very interested in new cooling technologies and that they would certainly not wish to end up as Kodak or Nokia, which were monopolies in the fields of photography and mobile telephony, but failed to follow the trends of digital photography or smart phones and are now practically non-existent. Smart companies follow the development of science. In our case, they quickly saw that elastocaloric cooling was still at a very basic level. I am therefore even happier about the ERC project, since we are tackling basic research which could become applied research in a few years. Our goal is to demonstrate the applied value of elastocaloric cooling technology in five years,

which will make it easier for us to cooperate with the industry once we have a prototype in our hands. Our strongest cooperation with the industry is currently in the field of shape-memory materials (which are also elastocaloric materials).

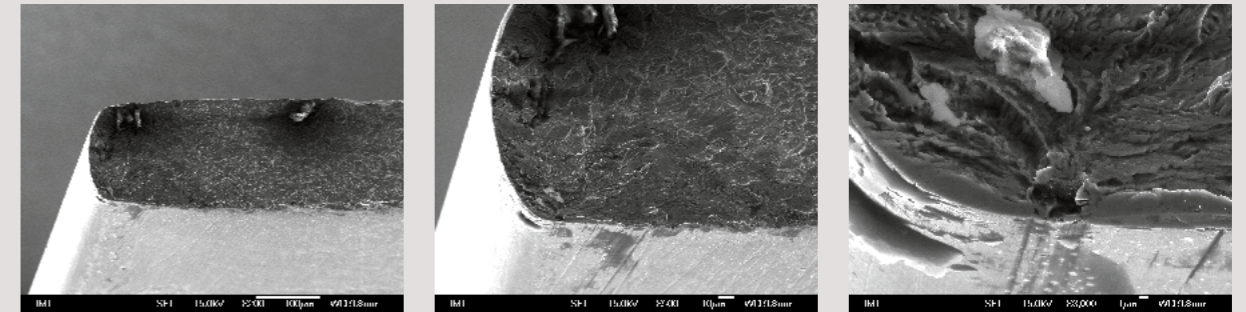
#### **Your idea will have to be accepted by the industry, which might change its mindset. Are we ready for this? I am not referring solely to Slovenia, but to the changes at a global level. Are we talking about world-changing applications?**

You are correct. We use cooling technologies several times a day without even being aware of it. Our standard of living has improved tremendously since we have been able to keep the food cool and prolong its shelf life. In the long term and in accordance with the optimal scenario, the elastocaloric technology could replace all the cooling systems, from household refrigerators and air conditioners to heat pumps, etc. The world wants a change, but things do not happen over night; changes can take decades. Development will be gradual. Our task is to first prove its useful value.

#### **How would you assess the current technological development and which of the technologies beneficial to the humankind do you think will develop the fastest?**

We often say that in the past 20 years, the world has changed more than ever before. This perception is mostly associated with the development of devices which make our lives easier. I believe that the biggest development occurred in telecommunications and in electronics in general. Other technologies have not changed as significantly. The technology used in refrigerators has not changed for the past two hundred years. We still burn coal or oil to produce electricity. I hope that we will find efficient and environmentally friendly energy conversion technologies, as energy is the key to development and crucial for the life of every individual. I hope that efficient energy conversion technologies will develop to the extent that they will no longer cause environmental damage to humankind.

Full interviews, conducted by Ina Petric, will be published on the website of Tromba Agency: [www.tromba.si](http://www.tromba.si)



## NEWS AND EVENTS



## ARRS Day 2018: Supporting Excellence

In line with the ARRS operation and development strategy 2016–2020, the vision of Agency's operation and development is based on seven strategic guidelines, including Open communication with the public and promotion of science. The main goal of the activities in the field of communication with the public is to

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

improve the scholarly aspect of reporting, as well as the public debate on science and the operation of the science system in the Republic of Slovenia. Communication with the public is based on

three values: openness, responsiveness and providing information of value. Openness is understood as a dialogue and responsiveness as providing information that is up-to-date, whereas providing information of value means communicating on current topics and relevant issues present in the media.

Since 2014, the Agency has been increasing its activities in the field of science promotion. As the first such event, the Agency organized the ARRS Day 2018: Supporting Excellence, dedicated to the new generation of young researchers and current international issues in supporting science.



*(from left to right) Prof. Dr. Marko Topič, Prof. Dr. József Györkös, Dr. Marc Schiltz, Prof. Dr. Jernej Pikalo and Prof. Dr. Gregor Anderluh (Photo: STA, Daniel Novakovič)*

290 participants took part in the event. 378 viewers tuned in the ARRS Day 2018 live-stream broadcast by our media partner STA on the STA science portal and STA Facebook profile. Online broadcasts of the plenary and welcome reception for the new generation of young researchers drew about 3700 viewers, whereby recordings of the events reached 870 views the next day.

The introductory section of the event was dedicated to a workshop on

available (co)financing mechanisms offered by the ARRS on the basis of progress along the research career path, and to a workshop on targeted use of funds and reporting.

The plenary section saw a debate on a number of national and European issues in the field of supporting science between key guests, Marc Schiltz, President of Science Europe, an association of research funding organizations, and the Luxembourg National Research Fund (Fonds National de la Recherche), prof. Jernej Pikalo, Slovenian Minister of Education, Science and Sport, and panelists prof. Marko Topič, President of the Agency's Scientific Council, and prof. Gregor Anderluh, Director of the National Institute of Chemistry.

The entire afternoon session of the event was dedicated to young people in science, especially to the new 34th generation of young researchers. The Mlada akademija society held a workshop on first-hand experience in starting out as a young researcher. It was followed by presentations of the most prominent research achievements in all disciplines in the framework of the ARRS science promotion project – Excellent in science 2018. This year's seventh edition of the Excellent in science project took on a new dimension, as the presentations were meant to inspire the new generation of future researchers.



*Recipients of the Excellent in science 2018 title as chosen by the Scientific councils of the various disciplines, presented their work at the event to inspire the new generation. Presentations of the most prominent research achievements in the framework of the ARRS science promotion project, Excellent in science 2018, are included in the Agency's annual report. (Photo: STA, Daniel Novakovič)*

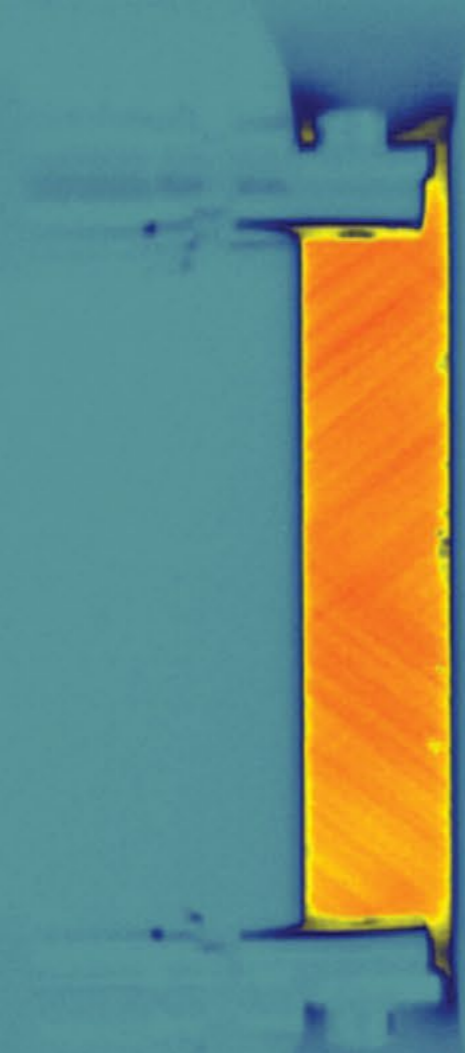


*Commemorative photo of the 34th generation of young researchers (Photo: STA, Daniel Novakovič).*

The event was concluded with a reception to wish the 34th generation of young researchers all the best on their paths towards obtaining doctoral degrees. Prof. József Györkös, Agency Director, and Gala Pavlin, member of the Administrative Board of VTIS, Society of Slovenians that obtained their education abroad, addressed the assembled guests.

Prof. Jernej Pikalo, Slovenian Minister of Education, Science and Sport, was the keynote speaker.

## FINANCING STRUCTURE



## Financing structure

In 2018, the budget of the Republic of Slovenia, through the Public Agency for Research Activities provided EUR 164.2 million for the financing of scientific research. Compared to the year before, the budget increased by EUR 15.9 million or 10.8 %.

The Agency's budget for scientific research activities decreased from EUR 175.9 million in 2011 to EUR 164.2 million in 2018, representing a difference of 6.7 %. The first budget increase since 2011 took place in 2016, when the budget was increased by 8.6 % compared to the year before.

In 2016, 1.52 % of the budget of the Republic of Slovenia was dedicated to the Agency for scientific research, in 2018, the share was 1.73 %.

Agency funds for scientific research activities and their corresponding share of the budget of the Republic of Slovenia<sup>1</sup>



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

<sup>1</sup> The funds for 2019 are shown in accordance with the cash flow principle.

## Agency funds in 2018

**Research programmes:** long term financing of research, which is expected to be topical and produce usable results over a longer time period.

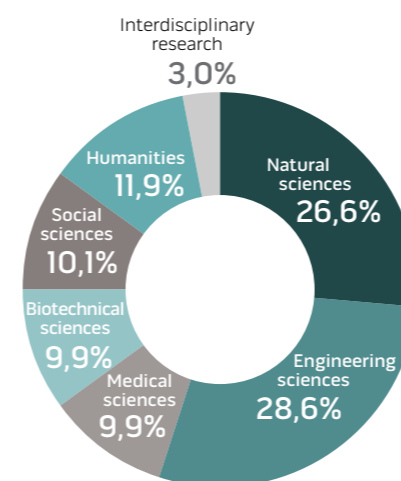
**Research projects:** co-financing of basic, applied and research projects, targeted research programmes and those of Doctors of science in the pilot public calls framework „Employment support of young Doctors of science“.

**Young researchers:** financing of postgraduate studies and training of researchers aiming to obtain a doctorate degree.

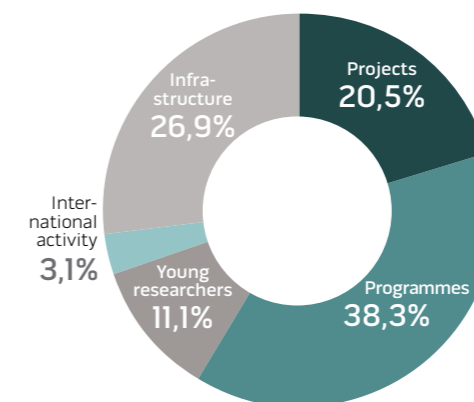
**International activities:** co-financing of projects within the complementary schemes of the ERC and the scheme of lead agencies, visits to ERC project leaders, launching of projects on the basis of the Marie Skłodowska-Curie seal of excellence, co-financing of bilateral cooperation, promotion of cooperation between research organizations 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, scientific and popular scientific periodicals and scientific monographs, founder's obligations, COBISS and other library-informatics activities and infrastructures, international periodicals and databases and research equipment.

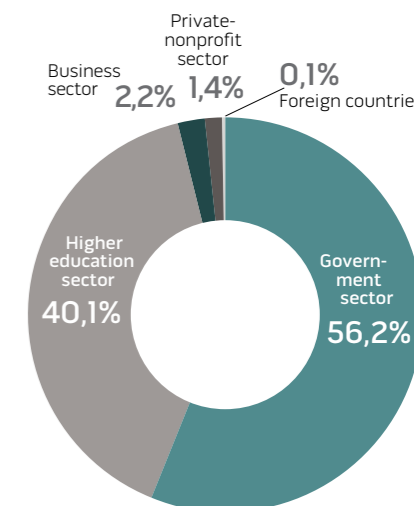
Distribution of Agency funds per discipline<sup>2</sup>



Distribution of Agency funds per mechanism



Distribution of Agency funds per activity sector



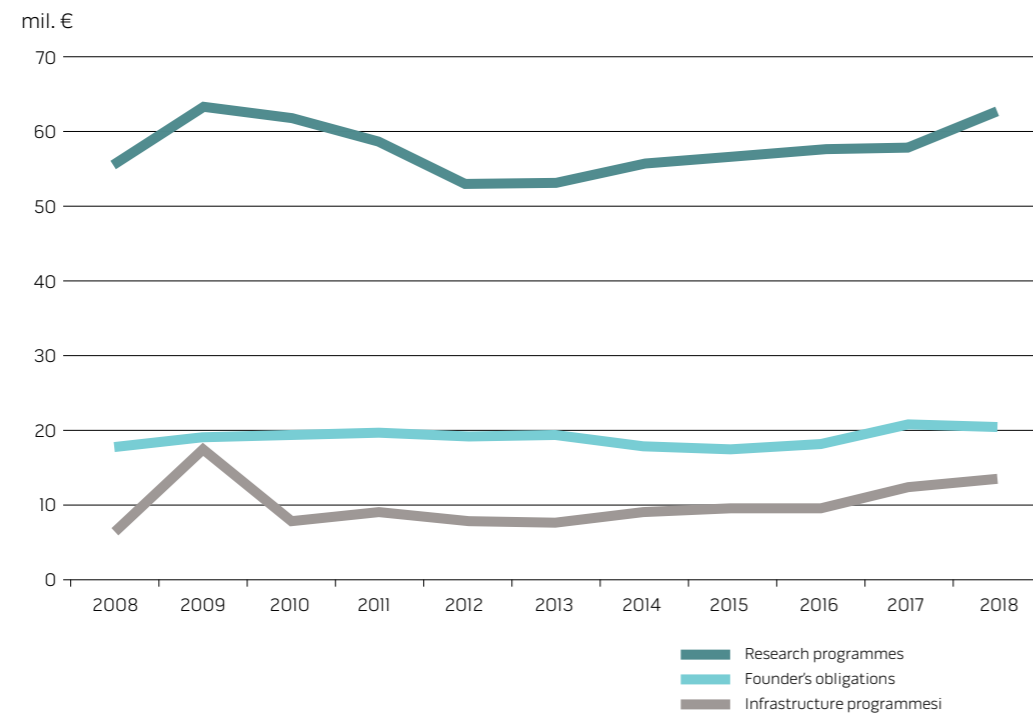
<sup>2</sup> Funding for founder obligations, infrastructural programmes, international promotion of science, the operation of Slovenian associations around the world, promotion of applications to EU projects, OSIC and foreign journal databases cannot be broken down per disciplines and are therefore not taken into account.



## Institutional financing

Research programmes: **EUR 62.9 mil.**  
 Founder obligations: **EUR 21.9 mil.**  
 Infrastructure programmes: **EUR 13.5 mil.**

Research programmes, infrastructural programmes and founder's obligations comprise a stable aspect of research financing. Due to austerity measures, the financing of research programmes in 2012 was reduced by 10 % in comparison with 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 slight growth in research programme funding was continued in 2016, 2017 and 2018.

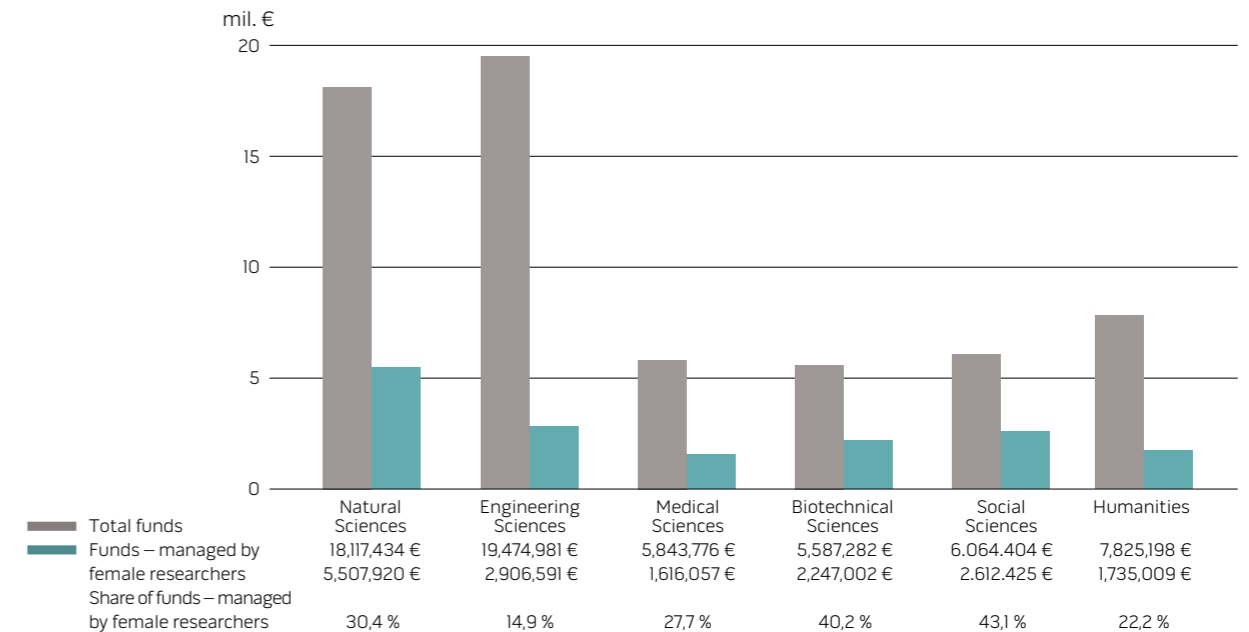


## Research programmes

In 2018, the Agency paid EUR 62.9 million for the co-financing of research programmes, which represents 38.3 % of the total budget. 297 research programmes were financed in 2018, of which 61 were in the field of natural sciences, 89 were in engineering sciences, 38 in medical sciences, 20 in biotechnical sciences, 44 in social sciences, and 45 in humanities.

### Call and tender in 2018

57 programmes whose financing period concluded in 2018 received an extension for the next six years in the total amount of EUR 11.2 million on the basis of a public tender and a public call. Financing in the amount of EUR 1.4 million was also approved for 10 new research programmes.



### Distribution of funding per activity sector in €

Public sector	34,074,397
Higher education sector	27,780,230
Business sector	811,156
Private non-profit sector	247,290
<b>Total</b>	<b>62,913,074</b>

The funding of research programmes increased by 8.6 % in comparison with 2017.

## Founding obligation and infrastructural programmes

Founder's obligations comprise the obligations of the founder to public research and infrastructural institutions, whereby the Agency covers fixed operation costs related to the core research or infrastructure activity. 21.9 million EUR was paid on founder's obligations in 2018, which represents an increase of 5.82 % in comparison with 2017.

### Founder's obligations funding per activity sector in €

Government sector	20,796,303
Higher education sector	1,082,071
<b>Total</b>	<b>21,878,374</b>

Infrastructural programmes support research works. The central role of research infrastructure is to ensure a high quality research environment. EUR 13.5 million was paid for infrastructural programmes in 2018, which represents 9.5 % more than in 2017.

### Infrastructure programmes funding per activity sector in €<sup>3</sup>

Government sector	9,126,934
Business enterprise sector	151,206
Higher education sector	3,242,098
Private non-profit sector	1,029,151
<b>Total</b>	<b>13,549,389</b>

<sup>3</sup> 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 organizations and individuals outside the political borders of the Republic of Slovenia.

## Competitive financing

Research projects: **EUR 33.7 mil.**

Young researchers: **EUR 18.2 mil.**

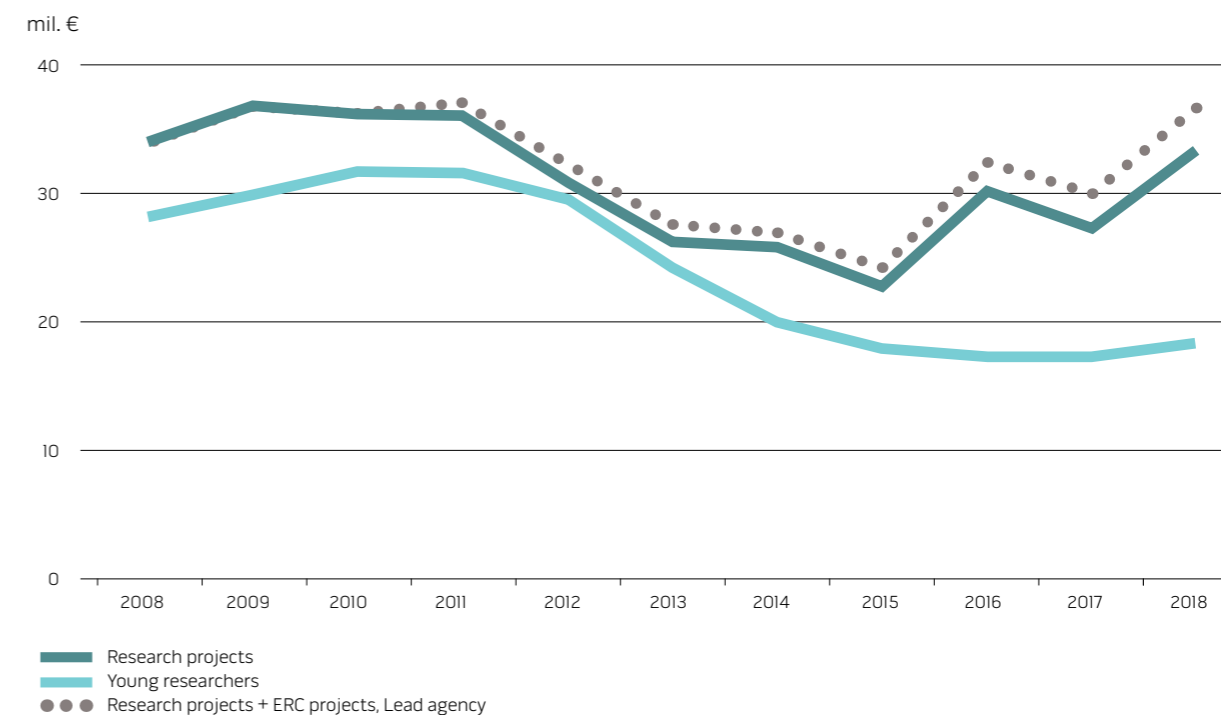
In 2018, the funding of research projects increased by 22.2 % in comparison with 2017. A significant decrease in funding was recorded in 2012, when the Agency did not finance any new research projects due to austerity measures. Financing of research projects decreased by 7.5 % between 2011 and 2018.

The increase in funding for research projects in 2016 was due to austerity measures in previous years and con-

sequent delays in the start of financing 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 young researcher training; in 2017, the funding decreased by 0.9 % in comparison with 2016. In 2018, the funding increased by 6.4 % in comparison with the previous year.

### Funding for research projects and young researchers

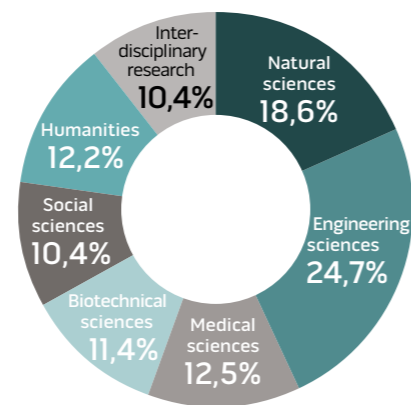


## Research projects

In 2018, the Agency co-financed research projects in the amount of EUR 33.7 million. Project funding represents 20.5 % of the Agency's total budget and is higher than in 2017 by 1.9 percentage points.

- Basic research projects: **EUR 23.3 mil.**
- Applied research projects: **EUR 6.4 mil.**
- Postdoctoral research projects: **EUR 2.6 mil.**
- Targeted research programme projects: **EUR 1.4 mil.**
- Promotion of the employment of young doctors of science: **EUR 17,000**

Funding for research projects per discipline



## Basic and applied research projects

In 2018, with finances from the state budget, the Agency co-financed 319 basic research projects, with a total value of EUR 23.3 million. In comparison with 2017, the funding increased by 27.5 %, in comparison with 2015, the increase amounted to 73.1 %. Young researchers (up to 10 years after defending their doctorate) conducted 98 basic projects, and received 32.5 % of the funding allocated for basic research projects.

Discipline	Basic and applied projects in mil. of €	Female researchers	Young leaders	Of those female researchers
Natural sciences	5,7	38,8 %	27,6 %	28,6 %
Engineering sciences	7,5	17,9 %	31,1 %	18,2 %
Medical sciences	3,6	44,3 %	78,5 %	54,3 %
Biotechnical sciences	3,1	35,5 %	22,1 %	54,0 %
Social sciences	2,9	43,9 %	27,4 %	45,9 %
Humanities	3,8	33,6 %	43,8 %	33,8 %
Interdisciplinary research	3,1	30,0 %	23,5 %	10,8 %
<b>Total</b>	<b>29,7</b>	<b>32,8 %</b>	<b>30,4 %</b>	<b>32,5 %</b>

The evaluation methodology for public calls for tender dictates that the share of applied research projects must be at least 30 % for engineering sciences, at least 20 % in the field of biotechnical sciences, at least 10 % in the field of medical sciences and social sciences, and at least 5 % in the field of natural sciences. The structure of all (co-)financed research projects strictly follows the implementation of the specified methodology.

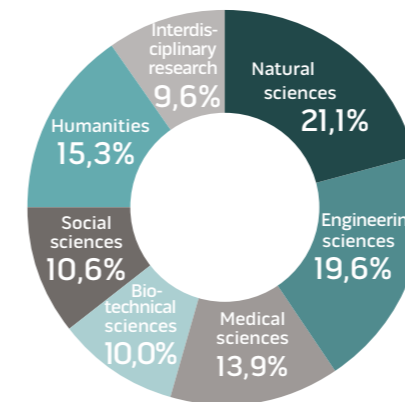
The evaluation methodology for applications to public calls for tender dictates that at least 20 % of chosen projects must be led by young researchers (male/female researchers, not more than 10 years after defending their doctorate). This is how the Agency promotes the integration of young scientists into its research activities.

The funding for basic and applied research projects with shares of projects led by female researchers and young researchers. Funding share data for projects led by young female researchers are given in the last column.

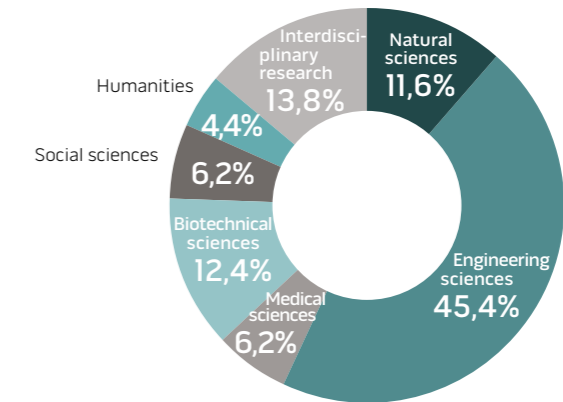
In 2018, with finances from the state budget, the Agency co-financed 80 applied research projects, with a total value of EUR 6.4 million, which is 15.5 % more than in 2017.

Young researchers conducted 19 applied projects, and received 23.0 % of the funding allocated for applied research projects.

Funding for basic research projects per discipline



Distribution of applied research project funding per discipline



### Postdoctoral projects

In 2018, with state budget funds, the Agency financed 67 postdoctoral projects, in the total amount of EUR 2.6 million, which represents an increase of 8.7 % compared to 2017.

The evaluation methodology for applications to public calls for tender dictates that at least 10 % of all projects within each discipline must be at post-doctoral level.

Funding for postdoctoral projects with shares of projects led by female researchers.

Discipline	Funding in €	Share - Female leaders
Natural sciences	559,578	37.9 %
Engineering sciences	687,401	26.7 %
Medical sciences	308,731	53.1 %
Biotechnical sciences	217,069	60.0 %
Social sciences	202,597	85.7 %
Humanities	221,870	78.3 %
Interdisciplinary research	371,417	74.0 %
<b>Total</b>	<b>2,568,663</b>	<b>51.1 %</b>

#### Public call in 2018

The funding of research projects, which were accepted into co-financing on the basis of the 2017 call, began in 2018. The funding of research projects for which the Agency published the co-financing of public calls in 2018, will begin in 2019..

### Targeted research programme (TRP) projects

In 2018, funds for co-financing TRP projects amounted to EUR 1.4 million or 23.9 % more than in 2017.

In 2018, 177 projects received funding in the framework of TRP. about fundamental development tasks, which are imperative for the increase of Slovenian competitiveness, adaptability and innovation.

The financing of TRP projects enables interested ministries and other users to gain research support for the design of strategic targets of Slovenia's development, and with decisions based upon the proposals of ministries and other parties who are competent to act in the public interest.

In 2018, the Agency published a public call for the selection of research projects within the framework of TRP entitled "Zagotovimo.si hrano za jutri" (Ensuring food for tomorrow).

In June 2018, the Agency, in cooperation with the Ministry of agriculture, forestry and food of the Republic of Slovenia, published a public call on selection of research projects within the framework of the TRP entitled "Zagotovimo.si hrano za jutri" (Ensuring food for tomorrow)..

The subject of the public call is based on the priorities as determined by the Ministry and encompasses the following four focal points:

- Slovenian food security;
- competitiveness in food production and renewable natural resources;
- sustainable management of natural resources;
- rural development.

The call was closed in December 2018 with 25 projects accepted for co-financing.

## Young researchers

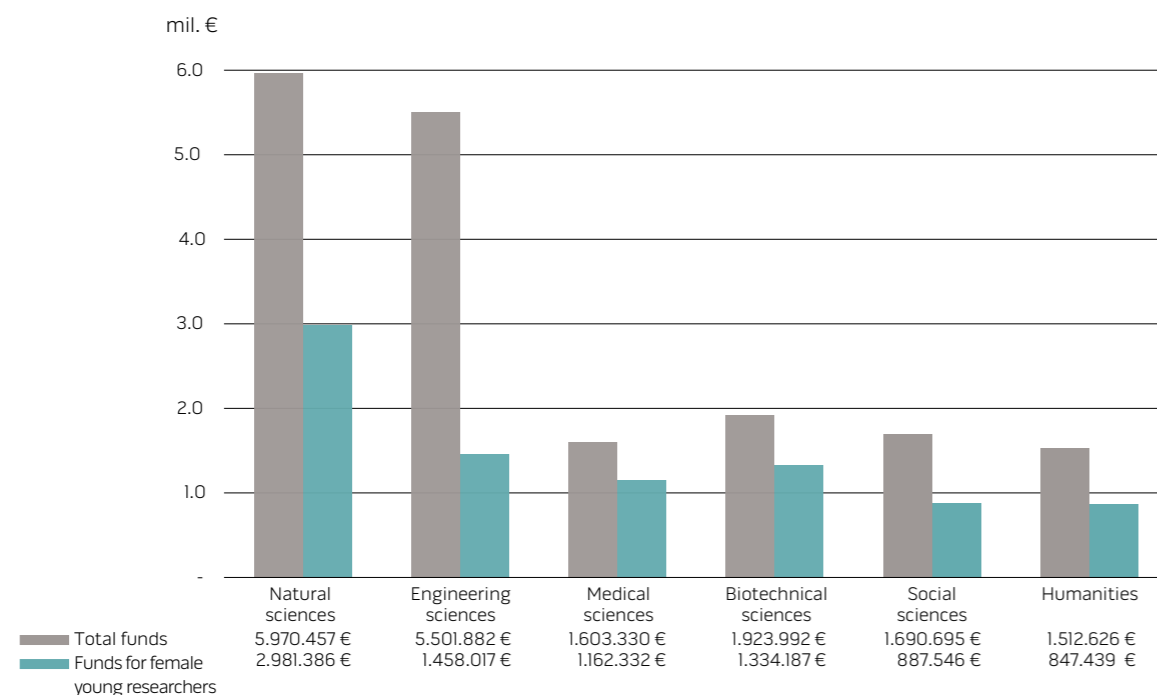
In 2018, the Agency financed the training of 899 young researchers, with a total funding of EUR 18.2 million, which represents 11.1 % of the Agency's total budget, and 0.5 percentage points less than in 2017. The Agency facilitates the participation of young researchers in research work during their postgraduate studies on the basis of temporary employment contracts.

Their salaries, social contributions and material and service costs are financed by the Agency. The average annual cost of financing one young 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 by promoting new

ideas and approaches. The young researcher programme is a source of highly qualified and motivated employees, who represent a significant potential for the Slovenian economy and other socially important areas. Within the framework of the programme, approximately eight thousand young researchers were trained between 1985 and 2016.

In 2018, two young researchers received the award for the early completion of training.

### Funding for young researchers



#### Support for young mentors

The Agency's regulations stipulate that among the accepted mentors of young researchers within the research organization, at least 25 % must be young mentors.

#### Public call in 2018

In January 2018, the Agency published a call for the allocation of mentorship positions within research programmes, leading to 175 mentorship positions being allocated among 147 research programmes: 55 in the natural sciences, 55 in engineering sciences, 18 in medical sciences, 16 in biotechnical sciences, 16 in social sciences, and 15 in humanities.

#### MR+ tender

In January 2018, the Agency published the MR+ pilot public tender for selection of mentors for the selection of mentors to new young researchers for 2018. The subject of the tender were 50 mentorships for young researchers in the total amount of EUR 1.5 million. The training began in October 2018.

## Scientific literature

Scientific literature: **EUR 1.5 mil.**

International publications and databases: **EUR 5.4 mil.**

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 organizations and via the CO-BISS 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 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 science monographs important for the development of Slovenian scientific terminology, for presenting scientific achievements and findings in Slovenia and abroad to facilitate the spread of scientific culture. The co-financing of the scientific literature, including domestic scientific and popular science publications, commanded a sum of EUR 1.1 million in 2018, while EUR 0.4 million was channelled towards scientific monographs.

## International activities

The ERC complementary scheme: **EUR 0.8 mil.**

Within the framework of the complementary scheme, applicants from Slovenian research organizations 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 a customised project, which, based on its objectives and scope of work, takes into account the time required to customise the project as well as the amount of available funding. The Agency co-finances customised projects in accordance with a proposal from the Scientific Council and with respect to the budgetary options made available for the co-financing of projects conducted primarily in Slovenia.

In 2018, the Agency co-financed 13 projects within the complementary schemes framework, of which five were in natural sciences (45.9 % of funding), three were in engineering sciences (26.4 % of funding), three in the humanities (15.1 % of funding), one in biotechnical sciences (7.3 % of funding), and one in social sciences

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 complementary scheme, funding was approved for four out of a total of eight recipients of ERC projects in Slovenia.

(5.3 % of funding). Organizations in the higher education sector received 53.9 % of funds, while those in the government sector were allocated 46.1 % of funds.

The calls are aimed at individual projects focused on conducting leading pioneering research in all scientific fields and rank among some of the most competitive in the world, with a success rate of 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 European Research Council was established in 2007. It currently operates within the Horizon 2020 programme, accounting for 17 % of the budget. Since its inception, the ERC has financed more than seven thousand projects, selected from more than 65,000 thousand applications. Among the recipients of ERC funding are six Nobel Prize winners. In 2018, the total budget of the ERC's amounted to approximately EUR 1.86 billion. Over 70 % of the projects evaluated by an independent study achieved breakthrough scientific discoveries or significant progress, and about 25 % contributed to significant improvements. Source: <https://erc.europa.eu/>

The frontier research evaluation system established by the ERC is considered to be an exemplary „peer review“ system, and is recognized by basic research funding agencies worldwide.

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.

ERC funding will be allocated to eight researchers who have or will use these funds to conduct research in Slovenia.

Leta 2018 In 2018, prof. Roman Jerala from the National Institute of Chemistry received a grant for renowned researchers (Advanced Grant) in the amount of EUR 2.5 million. His project, MaCChines (Molecular machines based on coiled-coil protein origami), is the first Slovenian ERC project in the field of life sciences and chemistry. In 2018, doc. Jaka Tušek from the Faculty of Mechanical Engineering became the first recipient of the ERC grant for starting independent research (Starting Grant) in Slovenia. He received EUR 1.4 million for a 5-year project entitled "SUPERCOOL – Superelastic porous structures for efficient elastocaloric cooling". In 2019, a grant for renowned researchers (Advanced Grant) was allocated to prof. Jernej Ule from the National Institute of Chemistry. He received EUR 2.4 million for a 5-year project entitled "RNP Dynamics".

#### The lead agency scheme: **EUR 2.1 mil.**

Collaborative projects are currently underway between:

- 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 Agency promotes international scientific research via the lead agency scheme. By means of a co-operation agreement between the agencies of various political states, 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 the another agency takes on the co-financing of the researcher from their own political state without conducting an

additional review process. In 2018, the Agency co-financed 47 projects within the lead agency scheme, of which 26 were in the field of natural sciences (47.5 % of funding), seven in engineering sciences (16.7 % of funding), four in biotechnical sciences (10.2 % of funding), three in medical sciences (9.0 % of funding), three in social sciences (7.9 % of funding), two interdisciplinary projects (5.6 %) and two in humanities (3.1 % of funding). Institutions within the government sector received 50.7 % of the funding, while those in the higher Education sector were allocated 49.3 %.

#### International bilateral projects: **EUR 1.1 mil.**

In 2018, international bilateral scientific cooperation took place by coordinated efforts by the competent ministry and the Agency.

Cooperation was conducted with 15 countries – Argentina, Austria, Montenegro, France, Croatia, Italy, Japan, China, Hungary, Germany, North Macedonia, Russia, Serbia, Turkey and the United States of America. The majority of funds were allocated to cooperation with the United States of America (30.4 %).

The Agency also cooperates 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. On the basis of four public calls in 2018, 21 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.

Cooperation with CEA in 2018 was co-financed in the amount of EUR 541,000, which represents an increase of 14.7 % in comparison with 2017.

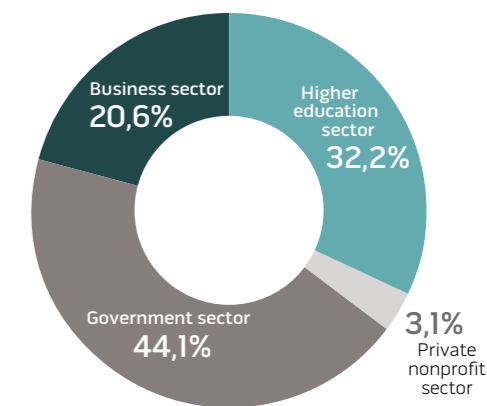
#### Horizon 2020 public call application incentive: **EUR 0.3 mil.**

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

Research organizations (ROs) who are, on the day of submission of the application for a public call, registered in the Register of ROs, managed by the Agency, and are project coordinators or partners eligible for a one-time financial contribution toward the cost of the project's application to the EU Horizon 2020 Programme for Research and Innovation. EUR

2,000 is the fee to help cover the costs incurred by the preparation and application of a project that has been coordinated and applied to the international consortium by a Slovenian organization that submits a project independently to the international consortium, assuming the call was anticipated by the European commission.

Funds by sector activity



#### Support for the promotion of science abroad and membership in international associations: **EUR 0.3 mil.**

The Agency co-finances the promotion of Slovenian science and knowledge, thus providing support for active participation in events organized by recognized international associations, international organizations or the European Commission. In addition, the programme also facilitates cooperation with Slovenian research organizations and researchers from neighbouring states, as well as co-operation with Slovenian researchers working abroad. The public call includes innovative activities for the promotion of Slovene science abroad with the aim of supporting new, pervasive ideas in the field of promotion and communication of science. In 2018, the Agency (co-)financed the following innovative activities:

- STA science 3.0 – Slovenian scientific achievements in media across the globe;
- SiNAPSA, Slovenian Neuroscience Association – p3Z (pilot: Knowledge for Health);
- Kvarkadabra – Innovative tool for promoting science;
- Tromba portal – Pitia promotion activity – synergy of different viewpoints for the advancement of the modern society;
- Science on the Street, Knowledge and Ideas on the go;
- META science podcasts: Meta PHoDcast and Metamorfoza;
- Research Centre of the Slovenian Academy of Sciences and Arts in cooperation with the team behind the Ugriznimo znanost TV

show by radiotelevizija Slovenija – Exploring Karst and the development of Karstology in the Altai Republic.

In 2018, the Agency once again included a new element of the public call, introduced in 2017 – the promotion of the establishment and development of global integration platforms.

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

## THE AGENCY'S INTERNATIONAL COOPERATION – HIGHLIGHTS





## One of the highlights of 2018 was the preparation of new scientific cooperation activities to strengthen efforts in this field

### Four Central European agencies, including ARRS, signed a letter of intent on establishing a Central European Science Partnership – CEUS

Within the framework of events taking place due to Austrian presidency of the Council of the European Union, four Central European agencies, including ARRS, signed a letter of intent on establishing a Central European Science Partnership (CEUS) in September 2018.

CEUS founding partners, the Austrian, Czech, Polish and Slovenian

research agencies, reached the agreement to establish a closer partnership intended to promote international cooperation in the field of science and strengthen cooperation in Central Europe based on existing mechanisms and development of new ones. Strengthening research cooperation among research communities in partner states through

preparing joint and compatible approaches to financing research is one of the main goals of the CEUS partnership.

The first activity of CEUS is the preparation of a multilateral leading agency pilot scheme with the aim for partner states to conclude the implementation agreement in 2019.

### Establishment of Science Europe working group to prepare a multilateral leading agency scheme

In 2018, Science Europe, European association of agencies, established a working group to review the options to conclude an agreement on a multilateral pan-European leading agency. The working group is comprised of 18 agencies: Austria – FWF,

Czech Republic – GACR, Finland – AKA, Belgium, Flanders – FWEO, Belgium, Wallonia – FNRS, France – ANR, Croatia – HRZZ, Ireland – SFI, Luxembourg – FNR, Germany – DFG, Netherlands – NWO, Norway – RCN, Poland – NCN, Portugal – FCT, Slovenia

– ARRS, Sweden – FORMAS, Switzerland – SNSF and Great Britain – UKRI. The goal of the working group is to conclude a multilateral agreement that would allow for the first calls for research projects to be published in 2020.

### Procedures to conclude leading agency agreements with the Swiss SNSF foundation and the Croatian HRZZ foundation

In spring 2018, the Agency entered into the process of mutual bilateral exchange of information on operation with the Swiss SNSF foundation

and the Croatian HRZZ foundation, as well as a thorough review of the call publication and research project evaluation. The leading agency

agreements were concluded at the beginning of 2019.

More information is available in the Events and News section.

### ARRS guiding principles for international cooperation: opening up opportunities for closer international cooperation in the field of science (ARRS operation and development strategy 2016–2020)

#### First stage: establishing and strengthening international connections

##### Incentives:

1. **Bilateral cooperation** – mobility incentives, concluded agreements between the Republic of Slovenia and 39 countries across the globe
2. **COST actions** – strengthening international connections
3. **Horizon 2020** – contributions towards application costs
4. **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 cooperation in the field of science

##### Possibilities: public calls and invitations

1. **Leading 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 project 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)

#### Forthcoming incentives and mechanisms:

##### Regional incentive – Central European Science Partnership (CEUS)

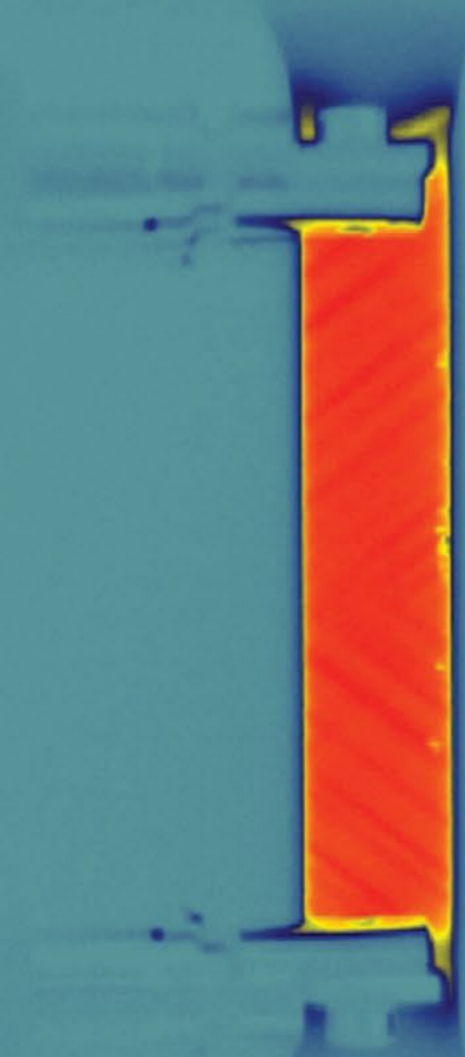
Preparing a multilateral leading agency pilot scheme between four countries (Austria, Slovenia, Czech Republic, Poland)

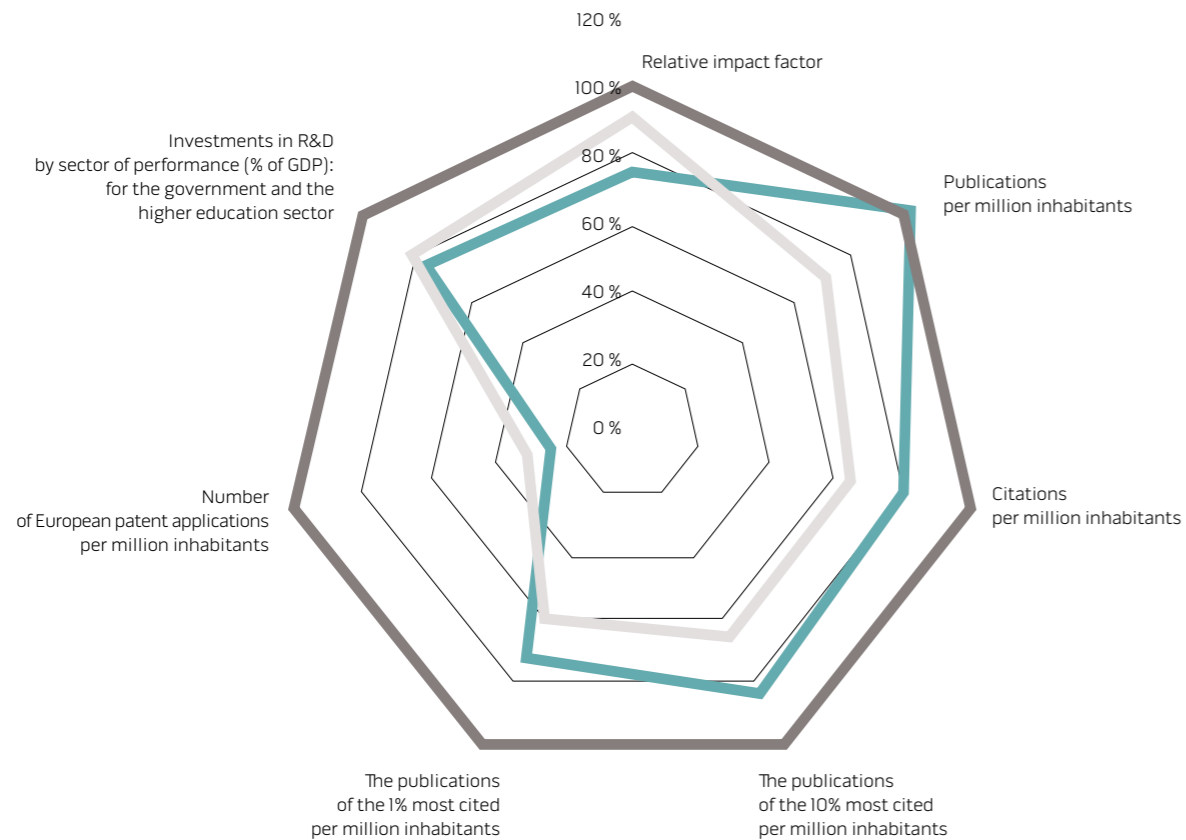
##### Multilateral lead agency schemes (MLA)

Science Europe working group to review possibilities to conclude an agreement on a multilateral pan-European lead agency (cooperation between 18 European agencies)

More information: <http://www.arrs.si/en/medn/index.asp>

## INTERNATIONAL COMPARISONS





— Slovenia  
 — EU Member State ranking 9th  
 — EU Member State ranking 14th

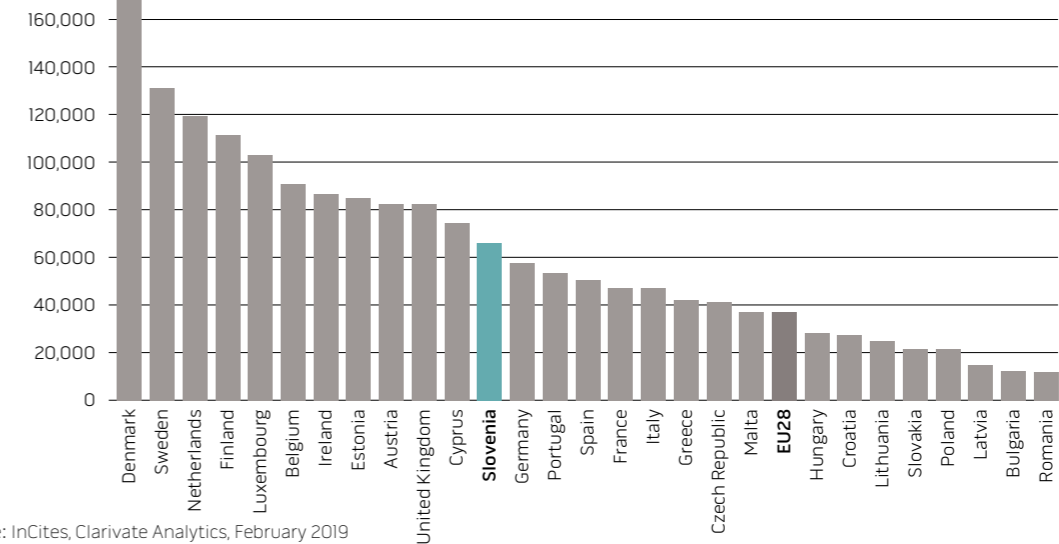
The diagram shows the majority of standard bibliometric and other quantitative indicators that are used for monitoring research activities worldwide and are also included in the Resolution of the Research and Innovation Strategy of Slovenia 2011–2020. The values for Slovenia are shown in relation to the EU member states ranked ninth (the upper third of member states). Information for the 14th country (the upper half of member states) is shown for comparison.

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

## Citations

According to the number of citations per million inhabitants, Slovenia with 65,366 citations is ranked 12th for the 2014–2020 period. In the same period, the number of citations per million inhabitants was the highest in Denmark, followed by Sweden, the Netherlands and Finland.

Number of citations per million inhabitants of the EU Member States in the 2014–2018 period

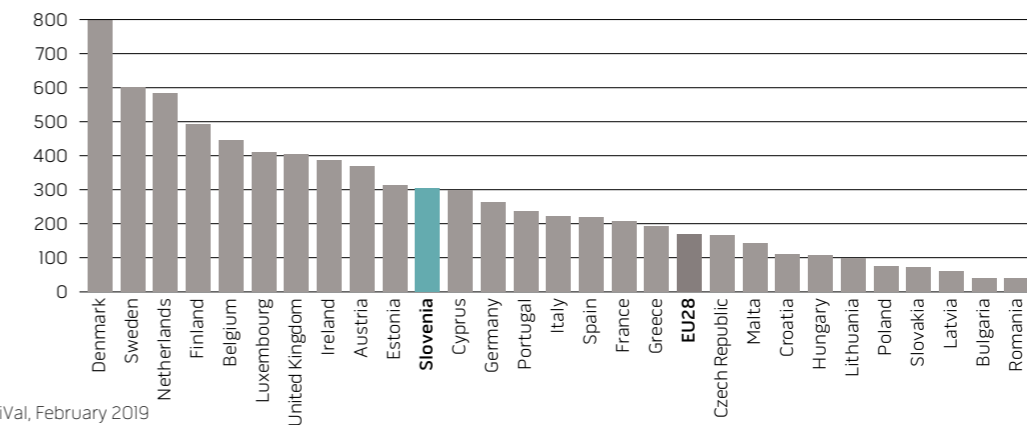


Source: InCites, Clarivate Analytics, February 2019

## 10 % of the most cited publications

The established bibliometric indicator used for international comparisons is the number of publications of researchers in a particular country who are ranked among 10 % of highly cited publications globally in a specific scientific field. This includes the publications in journals indexed in the Scopus bibliographic database. A four year period including the year of publication is taken into consideration. According to the latest data from 2015, Slovenia ranks 11th among the EU Member states.

The number of publications within the 10 % highly cited per million inhabitants in the EU member states in 2015



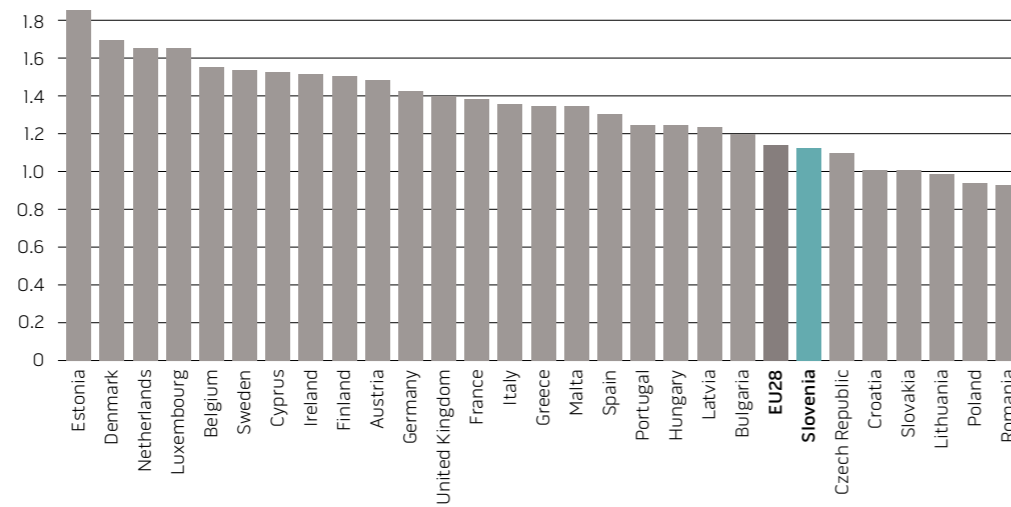
Source: SciVal, February 2019

### Relative impact factor

The relative impact factor is a standard international bibliometric indicator measuring the ratio between the number of received citations and the number of publications in a particular country according to the worldwide average impact factor in a par-

ticular scientific field. In terms of the relative impact factor, Slovenia ranks 23rd among EU Member States. Despite the above-average growth of the impact factor, the value of this indicator remains below the European average.

Relative impact factor for EU Member States in the 2014–2018 period



According to data from 2019, the value of the relative impact factor is higher than in 2018, which amounted to 1.12. In 2018, Slovenia was just below the European average (1.14).

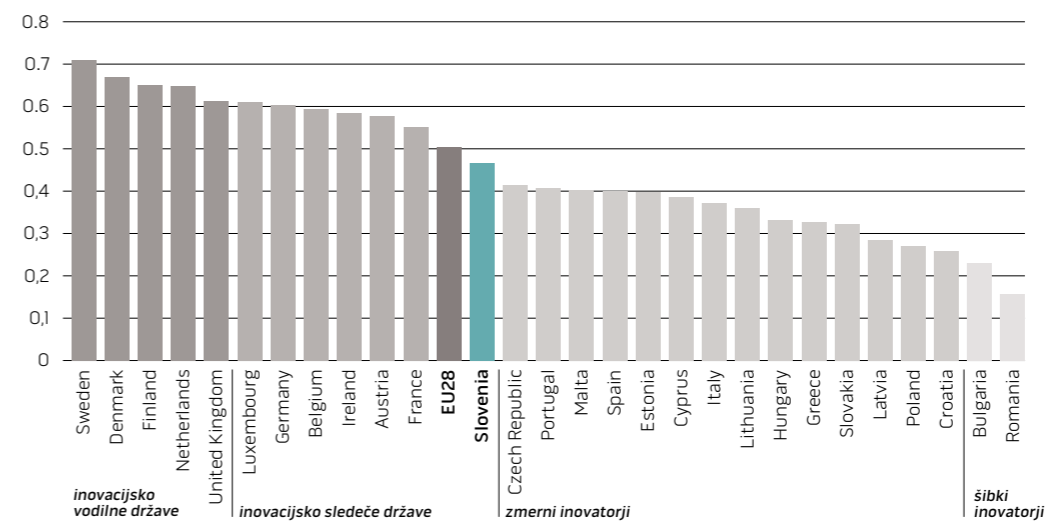
Source: InCites, Clarivate Analytics, February 2019

### Innovation index

The Innovation Union Scoreboard provides a comparative assessment of the innovation performance of individual countries. It is a composite indicator building on data for more than 20 indicators covering the educational structure, openness and excellence of the research system, financing, support and investment, cooperation and entrepreneurship

and on the intellectual capital. In terms of the level of innovativeness, the countries are classified into four groups: the leading countries, the following countries, the moderate innovators and the poor innovators. Given the listed indicators, Slovenia ranks 12th among EU Member States.

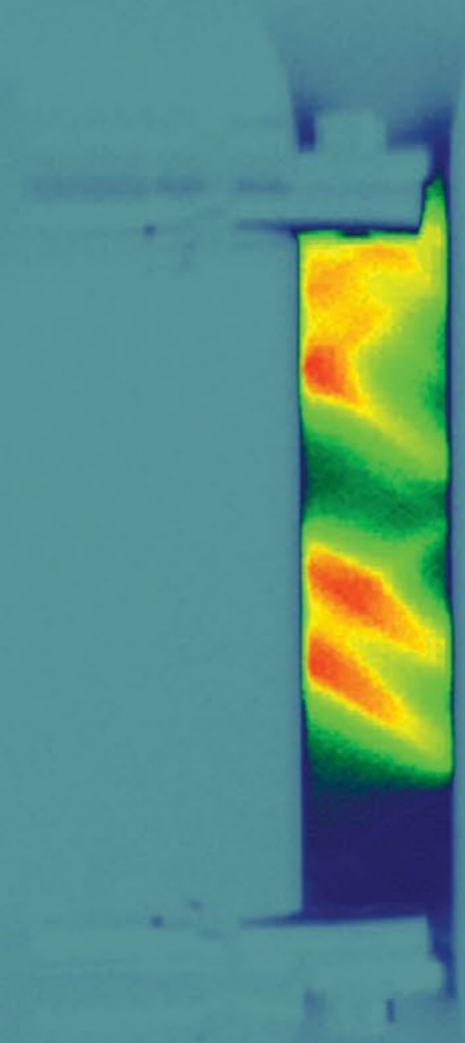
Innovation index for the EU Member States in 2017



International comparisons and other analyses are published on the following website: <https://www.arrs.si/en/analize/index.asp>.

Source: Innovation Union Scoreboard, 2017

## ABOUT THE AGENCY



### Strategic orientations of the Agency's operation and development

- sound implementation of activities according to the legal bases, Decision Establishing the Slovenian Research Agency, and applicable national strategic documents.
- transparency and responsiveness.
- optimization of instruments and setting-up pilot instruments.
- monitoring the effects of the implementation of the activities.
- international integration and comparability.
- transition to fully electronic services.
- communication with the public and science promotion based on three values: openness, responsiveness, providing information of value

### Internal organisational units

#### Director's office

The Director's office carries out specialised, advisory, coordination and administrative-technical tasks, and

coordinates the work on joint tasks with the Agency's internal organisational units and other bodies.



*Prof. Dr. József Györkös, Director*



*Dr. Lidija Tičar Padar, Deputy Director*

### Department of Research Programmes, Young Researchers and Analysis and Monitoring

This department evaluates and selects research programmes and carries out the tasks related to the young researchers programmes. It analyses and monitors the development of scientific research activities and actively develops the area of science promotion. Department activities include international cooperation in the Norface network and the

Joint Programming Initiative Urban Europe. The department also communicates with the public and promotes science, the aim being more professional reporting on science and on the operation of the science system in the Republic of Slovenia.  
**Head of Department:** *Dr. Marko Perdih, Assistant Director*



*Tina Vuga, Director's Cabinet International Relations Liaison and Public Relations Representative*

### 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 the objectives of research projects. The main activities

of this department are the launching of the call for proposals to receive co-funding for research projects and the launching of the call for proposals to receive co-funding for the Targeted Research Programmes projects.  
**Head of Department:** *Simon Ošo, Assistant Director*

### Department of Research Infrastructure and International Cooperation

This department carries out tasks in the field of research equipment and infrastructure programmes, central specialised information centres, scientific literature and bibliographical databases, international scientific research cooperation, promotion of science abroad, and 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, the setting up of complementary scheme in connection with the calls for proposals of the European Research Council and the hosting of third country researchers.  
**Head of Department:** *Mojca Boc*

#### Department of Legal and General Affairs

The Department of Legal and General Affairs carries out tasks in the fields of law and labour law procedures. It conducts administrative procedures regarding access to public information and keeping of private researchers register. The department manages the Database of Research and Development Actors. The department also carries out tasks related to personnel

and human resources management. It carries out procurement procedures related to the acquisition of funds and services, and provides for the maintenance of the Agency's business premises and equipment. The department serves as the Agency's head office, archives documentary materials and maintains the archive.

**Head of 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, recording and reporting on the financing of scientific research activities programme tasks, the functioning of the Agency, and the securing of the Agency's sol-

veny. It is also responsible for putting in place payment, recovery and control mechanisms, implementing accounting tasks, and coordinating the conclusion of joint contracts with research activity operators.

**Head of 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 coordinates the development of in-

formation 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 Department:** *Mitja Tomažič*

#### The overview of the funding in 2018 according to the programme sub-items on an accrual basis

	Realization 2018 (in EUR)
<b>FOUNDER'S OBLIGATIONS AND INFRASTRUCTURE PROGRAMMES</b>	<b>35,427,763</b>
The PRI founder's obligations	16,892,535
Infrastructure programmes – material costs	9,265,756
Reimbursement of work-related costs	4,985,838
Infrastructure programmes – salaries	4,283,633
<b>RESEARCH PROGRAMMES AND PROJECTS</b>	<b>97,591,692</b>
Research projects	29,725,706
Research programmes	62,913,074
ERA projects	284,272
ESF and ERC projects	3,148,042
Targeted research programmes – competitiveness	1,369,721
Open access	150,877
<b>TRAINING AND DEVELOPMENT OF SCIENTIFIC STAFF</b>	<b>20,806,024</b>
Young researchers	18,220,261
Postdoctoral projects	2,568,664
Promotion of the employment of young doctors	17,100
<b>RESEARCH EQUIPMENT</b>	<b>1,423,686</b>
Research equipment	1,423,686
<b>SCIENTIFIC LITERATURE, MEETINGS AND OSIC</b>	<b>7,227,519</b>
Domestic popular scientific periodicals	90,000
Domestic scientific periodicals	1,028,574
Scientific monographs	434,000
Foreign periodicals and databases	5,413,316
OSIC – centralized specialised information centres	255,629
<b>INTERNATIONAL SCIENTIFIC CO-OPERATION</b>	<b>1,728,460</b>
CEA, cooperation within the EU	541,166
International projects, bilateral cooperation	554,827
Encouraging applications for EU projects	320,000
Visits to ERC project leaders	42,796
Promotion of Slovenian science abroad	183,204
Operation of Slovenian scientific associations worldwide	86,466
<b>Total:</b>	<b>164,205,145</b>

Overview of funding by year is available on the following website: [www.arrs.gov.si/sl/finan/](http://www.arrs.gov.si/sl/finan/)

## Public calls and tenders that started in 2018

### Domestic tenders and calls

	Publication date
Public tender for selection of mentors for new young researchers in 2018 – MR+ pilot call	12. 1. 2018
Public call assigning mentor places to research programmes in 2018	17. 1. 2018
Public tender for co-financing of the purchase of research equipment – package 17	26. 1. 2018
Public tender for co-financing the publication of scientific monographs in 2018	26. 1. 2018
Public call for applications to increase the funding of research programmes	12. 2. 2018
Public call for research programme funding	16. 2. 2018
Public tender for co-financing of research programmes with concession	16. 2. 2018
Public call for co-financing the purchase of international scientific literature in 2018	16. 3. 2018
Public call for applications to increase the funding of research programmes	18. 5. 2018
Public tender for selecting research projects of the Targeted Research Programme "Zagotovimo.si hrano za jutri"	15. 6. 2018
Public call for the (co-)financing of research projects in 2019	24. 8. 2018
Public call for co-financing of publishing of Slovenian science periodicals in 2019 and 2020	21. 9. 2018
Public call for co-financing of purchase consortia in 2018	21. 9. 2018
Public call for co-financing of publishing of Slovenian popular science periodicals in 2019 and 2020	5. 10. 2018
Public call for reimbursement of costs for scientific publications in golden open access (for 2018)	19. 10. 2018
Public tender for selection of mentors for new young researchers in 2019 – MR+ call	9. 11. 2018

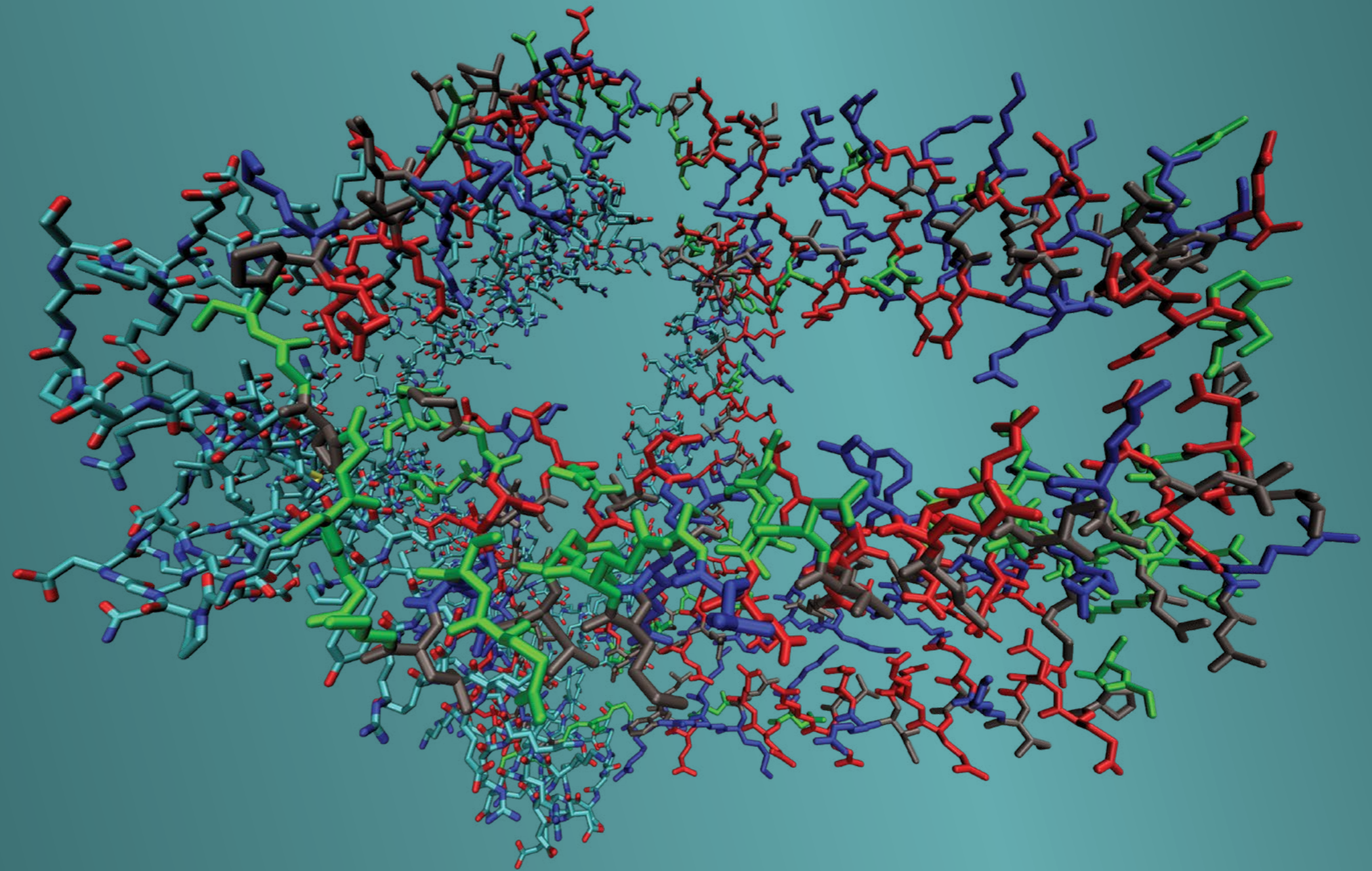
### International tenders and calls

Public tender for co-financing of the Slovenian share of joint Hungarian–Slovenian project with NKFIH (National Research, Development and Innovation Office) as the leading agency	19. 1. 2018
Public tender for co-financing of scientific research cooperation between the Republic of Slovenia and the French Republic – PROTEUS programme, 2019–2020	26. 1. 2018
Public tender for co-financing scientific research cooperation between the Republic of Slovenia and Hungary, 2019–2020	26. 2. 2018
Public tender for co-financing activities related to the promotion of Slovenian science abroad and integration of scientific achievements in 2018	9. 3. 2018

	Publication date
Public tender for co-financing of activities in international scientific associations in 2018	9. 3. 2018
Public tender for co-financing scientific research cooperation between the Republic of Slovenia and the Federal Republic of Germany, 2019–2020	1. 6. 2018
Public tender for co-financing scientific research cooperation between the Republic of Slovenia and Japan from April 1, 2019, to March 31, 2021	15. 6. 2018
Public tender for co-financing of scientific research cooperation between the Republic of Slovenia and the United States of America	29. 6. 2018
Public tender for co-financing of adapted research projects within the complementary scheme for applications to European Research Council (ERC) calls	20. 7. 2018
Public tender for co-financing scientific research cooperation between the Republic of Slovenia and Bosnia and Herzegovina, 2019–2020	7. 9. 2018
Public tender for co-financing scientific research cooperation between the Republic of Slovenia and the Russian Federation, 2019–2020	14. 9. 2018
Public tender for co-financing scientific research cooperation between the Republic of Slovenia and the Republic of Turkey, 2019–2020	26. 10. 2018
Public tender for co-financing of scientific and research cooperation between the Republic of Slovenia and the Commission for Alternative and Atomic Energy (CEA) in the period 2019–2021	26. 10. 2018
Public call for (co-)financing visits to ERC project leaders in 2019	26. 10. 2018
Public call for co-financing of projects with the Marie Skłodowska-Curie Seal of excellence	26. 10. 2018
Public tender for postdoctoral research scholarships in Japan for researchers from the Republic of Slovenia in 2019	23. 11. 2018
Public tender for payment of a one-time financial contribution toward the costs of preparation and application of projects in the framework of the EU Horizon 2020 Programme for Research and Innovation (2018)	3. 12. 2018
Public tender for co-financing of adapted research projects within the complementary scheme for applications to European Research Council (ERC) calls	21. 12. 2018
Public tender for co-financing of the Slovenian share of joint Flemish–Slovenian projects where the Research Foundation (Flanders, FWO) acts as the lead agency	21. 12. 2018



EXCELLENT IN SCIENCE



## Excellent in Science 2018

*Excellent in Science is a project carried out by the Agency as part of agency's endeavours to promote science. The project presents a selection of most prominent achievements from the past year.*

In 2018, some of the selected achievements were presented at the national event titled **ARRS Day 2018: Supporting Excellence**, held on 23 October 2018. 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.

## Natural sciences

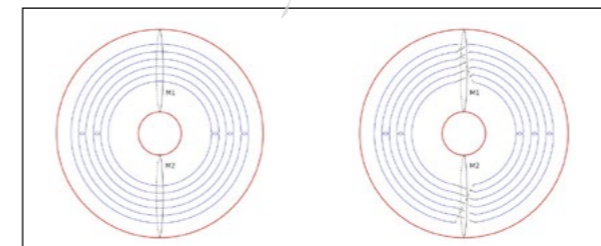
### Prof. Dr. Dušan Repovš

Contractible 3-manifolds and the double 3-space property: A solution of a difficult mathematical problem

Topological manifolds are locally nice spaces and belong to the most interesting objects of modern mathematics. They were introduced at the beginning of the previous century. Very important are contractible 3-manifolds, notably the Whitehead 3-manifold  $W3$ , which can be represented also as a union of two  $R3$ s whose cross-section is  $R3$  (therefore,  $W3$  has the property of the double 3-space LD3-P). In a paper published in one of the most important mathematical journals, the Transactions of the American Mathematical Society, we solved a difficult problem posed by the famous American mathematician David Gabai. We constructed uncountably infinite families of contractible 3-manifolds  $X3$  and  $Y3$  such that each  $M3$  from  $X3$  has the LD3-P, while no  $N3$  of  $Y3$  has this property. We have created a new approach, based on our research experience of the last 40 years that rank our research group among the best in this important field of modern mathematics.

Our result was received with great interest and has been successfully presented at international conferences. Manifolds will continue to be a very important field of research, since many fundamental problems remain open. They also have the potential for new research, e.g. to find structures that would explain the geometric and analytical aspects of various spaces.

Prof. Dr. Dušan Repovš, Institute of Mathematics, Physics and Mechanics  
[dusan.repovs@guest.arnes.si](mailto:dusan.repovs@guest.arnes.si)



Source: Dennis J. Garity, Dušan D. Repovš, David G. Wright, "Contractible 3-manifolds and the double 3-space property", Trans. Amer. Math. Soc. 370:3 (2018), 2039-2055.

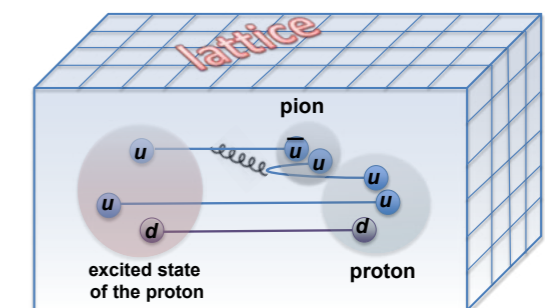
Hyperlink: <http://www.ams.org/journals/tran/2018-370-03/S0002-9947-2017-07035-5/>

### Prof. Dr. Saša Prelovšek Komej

Pion-nucleon scattering in the Roper channel from lattice QCD

The authors investigate the first excited state of a proton, which has been a puzzle since its discovery in 1964. The measured energy of this state is namely significantly smaller than predictions by theoretical models based on various approximations. The state is composed of quarks and gluons that interact via the strong force. Experiments reveal two decay modes of the state via strong interactions. The article presents the theoretical study of this state based directly on the fundamental theory of the strong interactions among its constituents. For the first time, the authors have taken into account its strong decays. Simulations establish that the energy of the state would be much larger if it decayed only via one decay mode. The results indicate that the smallness of the observed energy is related to the mutual interplay between the two decay modes. Theoretical studies of the strong force are challenging due to its large strength, which does not allow for an approach using increasingly better approximations. The authors employ complex simulations of the quantum chromodynamics on the lattice – the only approach based directly on the fundamental theory of the strong force.

Prof. Dr. Saša Prelovšek Komej, Jožef Stefan Institute [sasa.prelovsek@ijs.si](mailto:sasa.prelovsek@ijs.si)



Source: Pion-nucleon scattering in the Roper channel from lattice QCD Physical Review D 95 (2017) 014510 C.B. Lang, L. Leskovec, M. Padmanath and S. Prelovsek

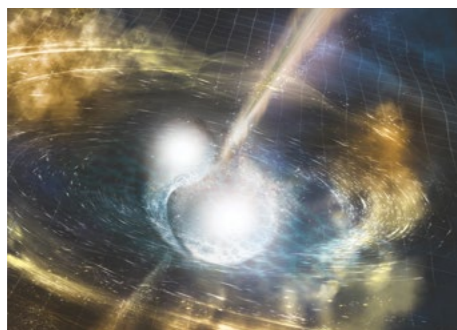
Hyperlink: <https://journals.aps.org/prd/abstract/10.1103/PhysRevD.95.014510>

### Prof. Dr. Andreja Gomboc

Detection of gravitational waves and light from a neutron star merger

The first direct detection of gravitational waves by the LIGO observatory in September 2015 was followed by several detections of similar black hole merger events. On 17 August 2017, however, the LIGO/Virgo detected gravitational waves produced by a merger of two neutron stars. Shortly after, satellites detected a gamma ray burst coming from the same part of the sky. A few hours later, ground-based telescopes detected visible light coming from this event. Based on these observations it was possible to precisely determine the origin of gravitational waves for the first time – the neutron star merger occurred in the galaxy NGC 4993, which is “only” 130 million light-years away. New observations, in which the researchers of the research program Astroparticle Physics took part, brought the first direct evidence that short gamma-ray bursts, which are among the most powerful explosions in the universe, are produced by neutron star mergers and are sites of heavy element production. The event marks the birth of the multi-messenger astronomy: it was the first event in which both gravitational waves and different types of light were detected, and was observed also by detectors of cosmic rays and neutrinos. The IOP Physics World magazine selected it for the Breakthrough of the Year 2017.

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Source: Covino, S., Wiersema, K., Fan, Y. Z., Toma, K., Melandri, A., D'Avanzo, P., ... Wijers, R. A. M. J. (2017). The unpolarized macronova associated with the gravitational wave event GW 170817. *Nature Astronomy*, 1(11), 791-794.

Hyperlink: <https://www.nature.com/articles/s41550-017-0285-z>

### Prof. Dr. Matjaž Kuntner

The *Nephila clavipes* genome highlights the diversity of spider silk genes and their complex expression

Spider silks are the toughest known biological materials, yet they are lightweight and virtually invisible to the human immune system, and they thus have revolutionary potential for medicine and industry applications. Spider silks are largely composed of spidroins, a unique family of structural proteins. To investigate spidroin genes systematically, we constructed the first genome of an orb-weaving spider: the golden orb-weaver (*Nephila clavipes*), a species renowned for its extreme sexual dimorphism (gigantic females and tiny males) and building gigantic webs using an extensive repertoire of silks with diverse physical properties. We catalogued 28 *Nephila* spidroins representing all known orb-weaver spidroin types and identified 394 repeated coding motif variants and higher-order repetitive cassette structures unique to specific spidroins. Characterization of spidroin expression in distinct silk gland types indicates that glands can express multiple spidroin types. We find evidence of an alternatively spliced spidroin, a spidroin expressed only in venom glands, evolutionary mechanisms for spidroin diversification, and non-spidroin genes with expression patterns that suggest roles in silk production. The work sets forth the first complete genome of an orb weaving spider emphasizing the complexity of silk genes.



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Source: Babb, P.L., Lahens, N.F., Correa-Garhwal, S.M., Nicholson, D.N., Kim, E.J., Hogenesch, J.B., Kuntner, M., Higgins, L., Hayashi, C.Y., Agnarsson, I. & Voight, B.F. 2017. The *Nephila clavipes* genome highlights the diversity of spider silk genes and their complex expression. *Nature Genetics* 49: 895–903.

Hyperlink: <https://www.ncbi.nlm.nih.gov/pubmed/28459453>

### Prof. Dr. Janez Košmrlj

Redefinition of an important catalytic reaction mechanism

Understanding reaction mechanisms is a cornerstone in chemical sciences that allows a rational design and optimization of chemical processes. Palladium catalysed arylation of terminal acetylenes enables an efficient synthesis of many important natural products and compounds of pharmaceutical or agrochemical importance. Despite the enormous success of this cross-coupling reaction, lasting for nearly half a century, critical mechanistic questions remained unresolved. We have discovered that this reaction proceeds through the so called bicyclic rather than the previously incorrectly proposed monocyclic mechanism. Experimentally, this has been supported by identification of reaction intermediates using state of the art nuclear magnetic resonance spectroscopy and mass spectrometry, as well as kinetic studies.

This work will contribute to the knowledge of metal-catalysed reactions in general, having favourable economic and environmental implications in relevant industrial chemical

processes. The Editors of *Nature Communications* selected this work for the Organic Chemistry and Chemical Biology Editors' Highlights.



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Source: Martin Gazvoda, Miha Virant, Balazs Pinter, Janez Košmrlj: Mechanism of copper-free Sonogashira reaction operates through palladium-palladium transmetalation, *Nature Communications*, 2018, 9, 4814.

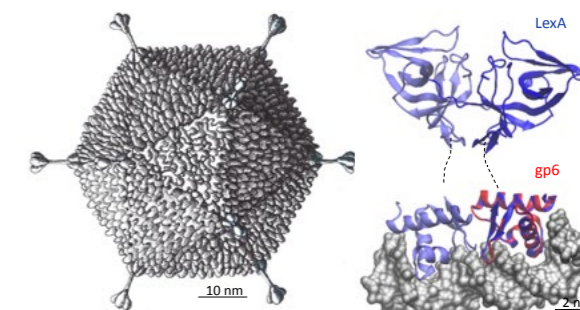
Hyperlink: <https://www.nature.com/articles/s41467-018-07081-5>

### Assis. Prof. Dr. Matej Butala

Lytic gene expression in the temperate bacteriophage GIL01 is activated by a phage-encoded LexA homologue

Viruses that infect bacteria (phages) represent the most abundant biological entities on the planet, having an enormous impact on microbial communities and bacterial evolution. For the successful development of phage progeny, they have evolved diverse and sophisticated mechanisms to take over essential bacterial processes. To date, such host takeover mechanisms have only been thoroughly studied in detail for a handful of phages.

The phage GIL01 infects the insect pathogen *Bacillus thuringiensis*. We resolved that a small GIL01-encoded protein, gp7, modulates host LexA transcription repressor to establish GIL01 dormant state inside a bacterium. Here we show that the second small phage protein, gp6, is the genetic switch, the inducer of the GIL01 resurrection leading to phage particle formation and initiation of the host cell lysis. Surprisingly, gp6 evolved from the host LexA; thus we provide a rare example of how two related proteins with opposing functions control the phage life cycle switch. The here resolved GIL01 molecular mechanisms inspired us to set forth research to develop novel antibacterial compounds based on GIL01 small proteins.



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Source: Fornelos N, Browning DF, Pavlin A, Podlesek Z, Hodnik V, Salas M, Butala M. 2018. Lytic gene expression in the temperate bacteriophage GIL01 is activated by a phage-encoded LexA homologue. *Nucleic Acids Res.* 46, 18, 9432-9443.

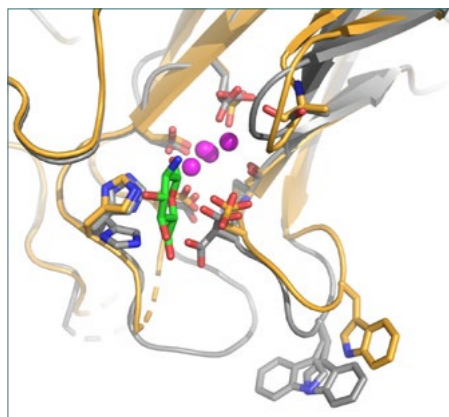
Hyperlink: <https://academic.oup.com/nar/article/46/18/9432/5057082>

## Prof. Dr. Gregor Anderluh

Selectivity of NLP cytolysins for eudicot sphingolipids

NLP proteins, necrosis- and ethylene-inducing peptide 1 (Nep1)-like proteins, are widely distributed among prokaryotic and eukaryotic organisms, like fungi, bacteria and oomycetes. To decipher NLP toxic mechanism, we identified glycosylinositol phosphorylceramides (GIPCs), an abundant class of plant sphingolipids in eudicot plant cell plasma membranes, as target molecules for NLP proteins. X-ray crystallography structural studies complemented with a variety of biochemical and biophysical experiments revealed that NLP<sub>Py</sub> forms complexes with terminal hexose moiety of target plant GIPCs. Hexose binding adjacent to divalent cation induces several conformational changes, such as widening of the divalent cation-binding crevice. The dimension of the newly formed crevice corresponds to the size of the GIPC sugar headgroup, which is predominantly present in the eudicot plants, but not monocot plants. Understanding of a peculiar Nep1-like proteins

mechanism of action at the molecular level represents a crucial step in restraining NLP-derived diseases as they govern agronomic performance and cause billion-dollar damage in many parts of the world.



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Source: Tea Lenarčič, Isabell Albert, Hannah Böhm, Vesna Hodnik, Katja Pirc, Apolonija B. Zavec, Marjetka Podobnik, David Pahovnik, Ema Žagar, Rory Pruitt, Peter Greimel, Akiko Yamaji-Hasegawa, Toshihide Kobayashi, Agnieszka Zienkiewicz, Jasmin Gömann, Jenny C. Mortimer, Lin Fang, Adillah Mamode-Cassim, Magali Deleu, Laurence Lins, Claudia Oecking, Ivo Feussner, Sébastien Mongrand, Gregor Anderluh, Thorsten Nürnberger. Eudicot plant-specific sphingolipids determine host selectivity of microbial NLP cytolysins. *Science* 358, 1431-1434 (2017)

Hyperlink: <http://science.sciencemag.org/content/358/6/1431/1431>

## Dr. Kristina Ivančič

Provenance of the Miocene Sloven Gradec Basin sedimentary fill, Western Central Paratethys

The region of E and NE part of Slovenia consists of clastic sedimentary rocks, which were formed in the Pannonian Basin System. In the present study, these rocks were investigated in the Slovenj Gradec Basin (SGB), which represents its marginal part. The depositional environment, provenance, and tectonic setting were based on field work, and petrographic and geochemical analyses. The marine and terrestrial environment alternated frequently in the SGB from 17.2 to 14.2 Ma, due to the regression-transgression cycles of the Central Paratethys. Marine environment was determined on the basis of microfossils, determined in thin sections, and transitional environment was inferred from macrofossils and sedimentary structures. Sediments in the SGB were subjected to two tectonic processes: the collision of the European and African tectonic plate, and the extension of the Pannonian Basin System. Clastic sedimentary rocks originated mostly from the north and west (Eastern Alps, Eisenkappel magmatic belt), and subordinately from the south (Southern Alps). There were no signs of the provenance from the east (Pohorje area), which point to the strong paleogeographic changes during the last 14 Ma. In addition, further research allows us to determine sequence cycles, paleogeographic reconstruction, and mass movement susceptibility model in the investigated area.



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Source: IVANČIČ, Kristina, TRAJANOVA, Mirka, ŠMUC, Andrej, SKABERNE, Dragomir. Provenance of the Miocene Slovenj Gradec Basin sedimentary fill, Western Central Paratethys. *Sedimentary geology*, 2017, pp. 1–54.

Hyperlink: [https://www.researchgate.net/publication/320902103\\_Provenance\\_of\\_the\\_Miocene\\_Slovenj\\_Gradec\\_Basin\\_sedimentary\\_fill\\_Western\\_Central\\_Paratethys](https://www.researchgate.net/publication/320902103_Provenance_of_the_Miocene_Slovenj_Gradec_Basin_sedimentary_fill_Western_Central_Paratethys)

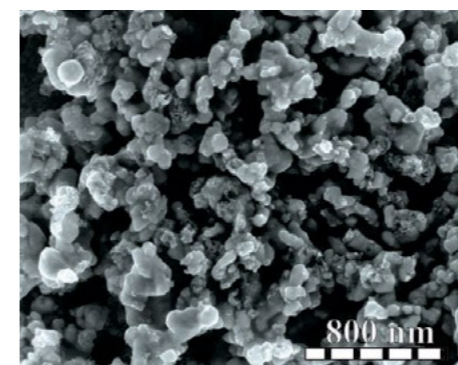
**Above:** Cross-bedded coarse-grained sandstone, and fine-grained conglomerate. **Below left:** Glauconite grain and echinoderm plate, indicating marine environment. **Right:** Oyster shells in the fine-grained conglomerate.

## Prof. Dr. Janez Ščančar

The use of nanoscale zero-valent iron particles for the treatment of effluent water from a small biological wastewater treatment plant

Global climate change, leading to more frequent droughts, pollution, and increasing consumption due to population growth, is the main cause of water scarcity. In order to ensure adequate quantities of drinking water in the future, the development of advanced water purification methods is needed so as to enable efficient use of alternative sources, such as waste water. Researchers from the Slovenian National Building and Civil Engineering Institute and the Jožef Stefan Institute have developed an innovative method to treat urban waste water from a small biological treatment plant based on the use of zerovalent iron nanoparticles (nZVI). These nanoparticles enable effective removal of pathogenic faecal bacteria and potentially toxic elements, and the removal of persistent organic pollutants. On the basis of laboratory research and optimization of advanced process, a prototype remediation device was developed which, with nanoremediation in combination with other cleaning procedures, enables the treatment of waste water to a degree which complies with physical-chemical and microbiological standards for its safe reuse.

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Source: OPRČKAL, Primož, MLADENVIČ, Ana, VIDMAR, Janja, MAUKO PRANJJIČ, Alenka, MILAČIČ, Radmila, ŠČANČAR, Janez. Critical evaluation of the use of different nanoscale zero-valent iron particles for the treatment of effluent water from a small biological wastewater treatment plant. *Chemical Engineering Journal*, ISSN 1385-8947. 2017, vol. 321, pp. 20–30.

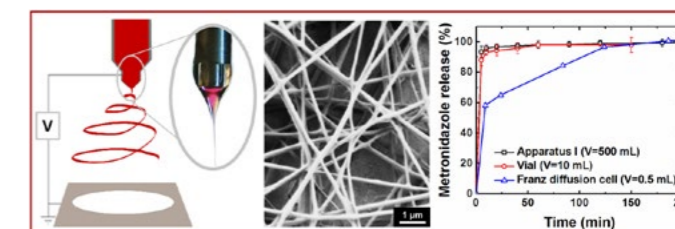
Hyperlink: <https://www.sciencedirect.com/science/article/pii/S1385894717304680?via%3Dihub>

## Prof. Dr. Julijana Kristl

Nanofibers as drug delivery systems

Nanofibers with an incorporated antibiotic represent a promising strategy for local treatment of many infectious diseases. However, their development and transition to therapeutic use are dependent on the availability of specific technologies for the production of the delivery system and on the methods used for their characterization. Our data for developed chitosan and polyethylene oxide nanofibers show that the release profile of an antimicrobial drug is highly dependent on the method used for evaluation of the in-vitro drug release. Therefore, to predict the drug release as accurately as possible, any evaluation method must ensure conditions that are as close as possible to the in-vivo environment (e.g., periodontal pocket, chronic wounds). The findings triggered the development of an innovative micro flow-through apparatus to study the release of low molecular weight drugs, biopharmaceuticals, or probiotics from nanofibers in vitro. The efficiency of an antimicrobial drug released from nanofibers was confirmed against selected strains of periodontopathogenic bacteria (doi: 10.1016/j.jps.2018.07.024). These original and unique data can be applied directly to the pharmaceutical research laboratories to develop and evaluate the quality and safety of (nano)medicines for administration in environments with very low body fluid volume and flow.

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**The principle of electrospinning, the appearance of nanofibers, and the drug release curves**

Source: Š. Zupančič, T. Potrč, S. Baumgartner, P. Kocbek, J. Kristl, Formulation and evaluation of chitosan/polyethylene oxide nanofibers loaded with metronidazole for local infections *Eur J Pharm Sci* 95, 2016, 52-160.

Hyperlink: <https://www.ncbi.nlm.nih.gov/pubmed/27989855>

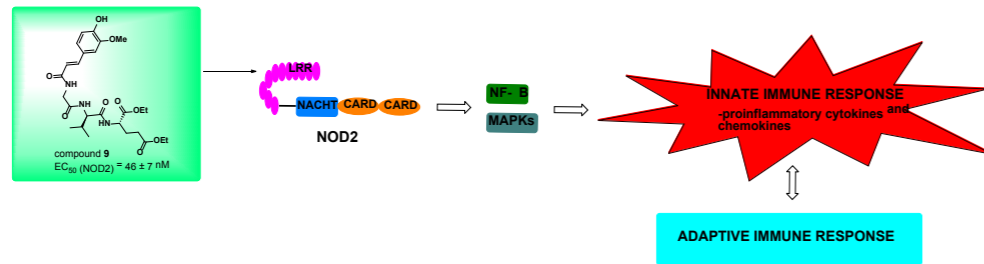
**Prof. Dr. Žiga Jakopin**

Development of novel nanomolar NOD2 agonists as potential vaccine adjuvants

Muramyl dipeptide (MDP) possesses good adjuvant properties due to its agonistic action on the nucleotide-binding oligomerization domain-containing protein 2 (NOD2), however, it suffers from certain drawbacks, hampering its use in the clinic. In the search for therapeutically useful MDP analogs, the authors designed, synthesized and characterized a series of novel desmuramylpeptides. The pivotal structural elements for molecular recognition by NOD2 have been identified, culminating in the discovery of compound 9, the most potent desmuramylpeptide NOD2 agonist to date. The latter proved superior to MDP in terms of increasing pro-inflammatory cytokine release from human peripheral blood mononuclear cells in synergy with lipopolysaccharide. It also exhibited adjuvant effect in a mouse model of adjuvancy by augmenting the antibody response to a model antigen –

ovalbumin. The results obtained enabled the authors to increase our understanding of the structural requirements of desmuramylpeptides for NOD2-activation. This achievement, which is a result of interdisciplinary efforts, was published in the most prestigious high impact journal from the field of medicinal chemistry. Adjuvants are an important component of modern vaccines, being able to increase the immune response following their administration, resulting in an increased efficacy of the vaccine. There is a pressing need for novel adjuvants for human use, and harnessing the innate immune stimulatory properties of NOD-like receptor agonists presents an exciting new avenue to be explored. The authors demonstrated that desmuramylpeptides can induce both innate and adaptive immune responses and thus highlight the potential utility of NOD2 agonists as vaccine adjuvants.

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Source: GOBEC, Martina, TOMAŠIČ, Tihomir, ŠTIMAC, Adela, FRKANEC, Ruža, TRONTELJ, Jurij, ANDERLUH, Marko, MLINARIČ-RAŠČAN, Irena, JAKOPIN, Žiga. Discovery of nanomolar desmuramylpeptide agonists of the innate immune receptor nucleotide-binding oligomerization domain-containing protein 2 (NOD2) possessing immunostimulatory properties. *J. Med. Chem.* 2018, 61, 2707-2724; IF = 6.259

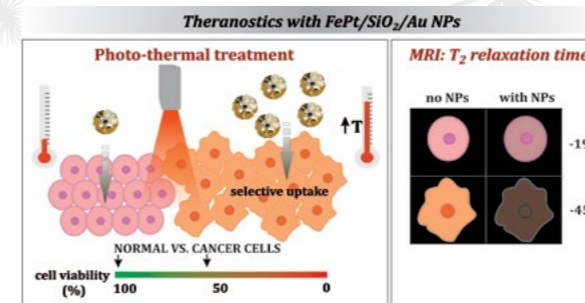
Hyperlink: <https://www.ncbi.nlm.nih.gov/pubmed/29543461>

**Dr. Nina Kostevšek**

Hybrid nanoparticles for cancer treatment and diagnostics

We have produced an innovative, theranostic material based on FePt/SiO<sub>2</sub>/Au hybrid nanoparticles (NPs) for both, photo-thermal therapy and magnetic resonance imaging (MRI). The cytotoxicity together with the internalization mechanism and the intracellular fate of hybrid NPs were evaluated on normal and cancerous cell lines. Control samples as well as the normal cell line incubated with the NPs showed no significant temperature increase during the photo-thermal treatment ( $\Delta T < 0.8$  °C) and thus cell viability remained high (~90%). On the contrary, due to high NPs uptake by the cancerous cells, significant heating of the sample was observed ( $\Delta T = 4$  °C) and, consequently, cell viability dropped significantly to ~60%. These results further confirm that the hybrid NPs developed in the scope of this work were not only efficient, but also highly selective photo-thermal agents. In order to improve the survival rate of cancer patients, reduce the treatment time and any possible side effects, radically new approaches in treatment and diagnostics are needed. To realize this, we focused on the development of multifunctional nanoparticles as an innovative "theranostatic" system (theranostics = therapy + diagnostics) with its efficacy and selectivity proven in vitro.

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Source: Kostevsek, N., et al.: Hybrid FePt/SiO<sub>2</sub>/Au nanoparticles as a theranostic tool: in vitro photothermal treatment and MRI imaging. *Nanoscale*. 10(3), 1308-1321. (2018)

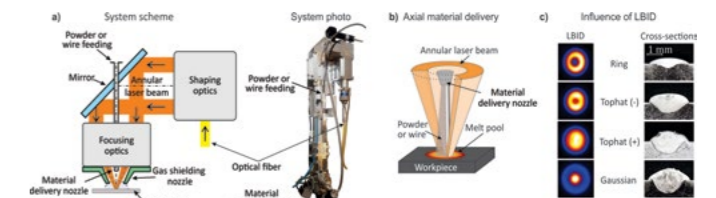
Hyperlink: <https://www.semanticscholar.org/paper/Hybrid-FePt%2FSiO2%2FAu-nanoparticles-as-a-theranostic-Kostevsek%25Alek-Abramovic/e524965314ab4e-2017f0795f62c1a5db2bc94c8f>

**Prof. Dr. Edvard Govekar**

Annular laser beam based direct metal deposition

In addition to laser selective melting, laser direct metal deposition (LDMD) is one of the most promising processes for 3D metal printing. Existing systems for LDMD use axial Gaussian laser beam and lateral supply of a metal material. In the frame of the research of LDMD process and in collaboration with a Japanese company DMG MORI, an opto-mechanical system (Fig. a) has been developed, which, based on shaping of an annular laser beam, enables axial delivery of metal material in the form of a wire or powder in the axis of the laser beam (Fig. b), and variation of the laser beam intensity distribution (LBID) on the workpiece surface from a ring and Tophat to Gaussian (Fig. c). Axial delivery of metal material ensures isotropy and higher stability of the process as well as powder catchment efficiency above 80%. Results also show that besides higher process stability, LBID influences also the shape of the deposited layer (Fig. c), thus indicating further possibilities of LDMD process optimization from the point of view of metallurgical and mechanical properties of the deposited metal layer and 3D printed metal parts.

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Sources: E. Govekar, A. Jeromen, A. Kuznetsov, G.N. Levy, M. Fujishima. Study of an annular laser beam based axially-fed powder cladding process. *CIRP annals*, 67 (2018) 241-244. E. Govekar, A. Jeromen, A. Kuznetsov, M. Kotar, M. Kondo. Annular laser beam based direct metal deposition (Invited paper), 10th Conference on Photonic Technologies [LANE 2018], 3.-6. September 2018, Fürth, Nemčija. M. Fujishima, E. Govekar, G.N. Levy. Head for additive processing, processing machine, and processing method. US2018-0036948, JPWO2017115406, EP3369518, WO/2017/115406 (2017, 2018).

Hyperlink: <https://www.sciencedirect.com/science/article/pii/S0007850618301069>

## Prof. Dr. Matjaž Mihelj

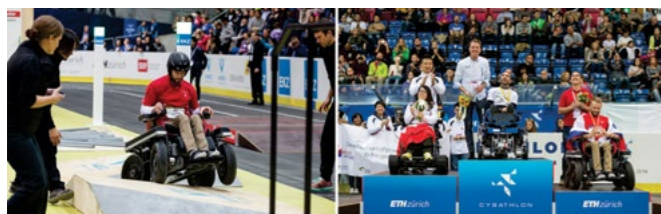
Robotic wheelchair

Electric wheelchairs considerably improve the quality of life in people with motor disabilities. However, beyond normal driving, they do not allow for traversing the most common obstacles (stairs, curbs). In the Laboratory of Robotics at the Faculty of Electrical Engineering, University of Ljubljana, we developed the concept of a robotic wheelchair:

- four-wheel drive with independent steering of each wheel (normal and crab steering, turning in place);
- tracks system for traversing the obstacles (curbs, stairs);
- ergonomically designed seat that can be actively reclined;
- advanced control system to support the use of the wheelchair.

At the Cybathlon competition which promotes the development of assistive technologies, the University of Ljubljana team won a bronze medal. Scientific achievement was published in one of the most prestigious robotic journals, IEEE Robotics & Automation Magazine. Robotic wheelchair is a research platform enabling the study of ergonomics, testing of advanced sensor technologies, and development and validation of new control concepts. The developed system is used for educational purposes and represents a test platform for the development of a new generation of commercially relevant robotic wheelchairs.

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Author:  
ETH Zürich/  
Alessandro  
Della Bella

Source: J. Podobnik, J. Rejc, S. Šljajpah, M. Munič and M. Mihelj, "All-Terrain Wheelchair: Increasing Personal Mobility with a Powered Wheel-Track Hybrid Wheelchair," in IEEE Robotics & Automation Magazine, vol. 24, no. 4, pp. 26-36, Dec. 2017.

Hyperlink: <https://ieeexplore.ieee.org/document/8100630>

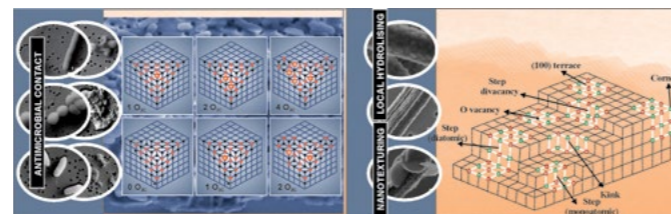
## Ddr. Marija Vukomanović

The role of surface defects in the mechanism of antimicrobial activity of magnesium oxide

Magnesium oxide (MgO) is approved by the FDA for various biomedical purposes in the form of additives and lubricants, and as muscle relaxant and pH adjustment agent. In addition, it has distinct antimicrobial activity based on specific contact with bacterial cells, but the mechanism of action and the nature of the processes between MgO and bacteria are not yet well understood. Researchers at the Jožef Stefan Institute have shown that MgO antimicrobial activity is based on a contact mechanism. It has been shown that a smaller number of oxygen atoms with a lower coordinate number on the MgO surface makes it possible to improve the resistance of the material to hydrolysis, and accelerate its antibacterial action. It has also been established that the ability of the formation of reactive oxygen species (ROS) is not a property of MgO, but is a by-product of hydrolysis resulting from the interaction between MgO and bacteria. Based on correlations between hydrolysis, antibacterial kinetics and the generation of the ROS species, it has been shown that the basic mechanism of action, which significantly contributes to the antibacterial activity of MgO, is the acid-base reaction between the surface of MgO and the bacterial wall.

Knowledge of basic principles of the interaction between MgO and cells, and the nature of processes occurring on their contact surface, is essential for improving the efficiency and design of future MgO-based medical devices and medicines.

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Source: N. Aničič, M. Vukomanović, T. Koklič, D. Suvorov, Small, 14 (2018).

Hyperlink: <https://onlinelibrary.wiley.com/doi/abs/10.1002/sml.201870123>

## Prof. Dr. Miran Gabršček, Dr. Primož Jovanovič, Dr. Nejc Hodnik

Stability of iridium based electrocatalysts

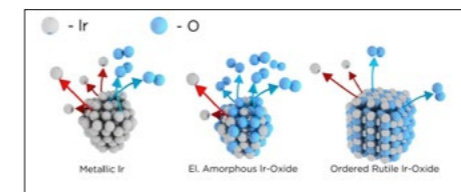
Electrolysers are considered a convenient solution to store energy obtained from sun or wind in the form of hydrogen. By developing completely new electrochemical methods, we were able to precisely determine the degradation mechanism of iridium electrocatalysts. The findings offer new guidelines for designing more efficient electrolysers.

Water electrolysis will inevitably play a key role in translation to sustainable energy infrastructure. State of the art research on water electrolysis strongly indicates that in order to provide for sufficient performance of electrolysers, a profound understanding of oxygen evolution reaction is of utmost importance. The bottleneck of this reaction is its sluggish kinetics, hence more efficient electrocatalyst should be developed. However, besides increasing the catalytic activity, one also needs to significantly improve the catalyst stability. In this respect iridium-based catalysts have turned out to be the most promising candidates to be employed as electrolysers. Our research comparatively investigated several iridium electrocatalysts. The comparison was based on 6 experimental methodologies half of which were developed specifically for the purpose of this study. Development of novel methodologies provided for new insights into the operating mechanism of iridium electrocatalysts and revealed that their stability was directly dependent on their oxidation state and crystal structure.

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Source: Journal of the American Chemical Society : JACS, ISSN 0002-7863, Sep. 2017, vol. 139, iss. 36, pp. 12837-12846.

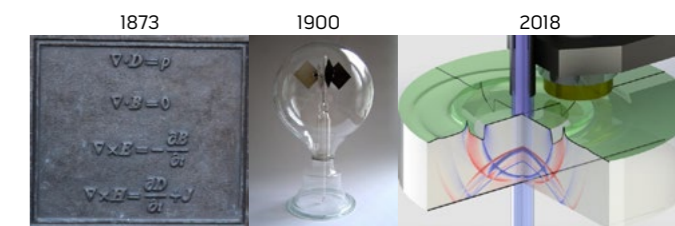
Hyperlink: <https://pubs.acs.org/doi/abs/10.1021/jacs.7b08071>

## Assist. Prof. Dr. Tomaž Požar

Listening to light reflections

When light comes into contact with matter, it sets it in motion—we say that light carries momentum. Despite the fact that such motion is not observed in daily life, it is responsible for the motion of comet tails as well as for the operation of optical tweezers, for which half of this year's Nobel Prize in Physics was awarded. The fact that light possesses momentum has been theoretically predicted already in 1873 and it was first measured in 1900, but only in terms of how it is transferred to the object as a whole. A detailed description of this transfer, published in August 2018 by the researchers of Faculty of Mechanical Engineering, University of Ljubljana in collaboration with three foreign institutions refers to the measurement and explanation of how the momentum of light is transferred to matter in time and space, and that during this process elastic waves are launched, resembling seismic waves, but with displacement-amplitude of merely a picometer. As part of the experiment, laser pulse was focused on a small mirror where the light was reflected, hit against the mirror at the same time, and launched elastic waves that were detected by a highly-sensitive displacement sensor.

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Timeline of ground-breaking discoveries about the momentum of light.

Source: POŽAR, Tomaž, LALOŠ, Jernej, BABNIK, Aleš, PETKOVŠEK, Rok, LUKASIEVICZ, G. V. B., BETHUNE-WADDELL, Max, CHAU, Kenneth J., ASTRATH, N. G. C. Isolated detection of elastic waves driven by the momentum of light. Nature communications, ISSN 2041-1723, 2018, vol. 9, f. 1-11

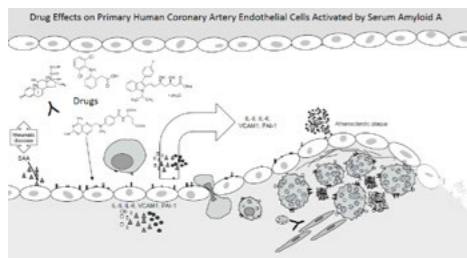
Hyperlink: <https://www.nature.com/articles/s41467-018-05706-3>

**Assist. Prof. Dr. Katja Lakota,  
Prof. Dr. Snezna Sodin-Semrl**

Drug effects on primary human coronary artery endothelial cells activated by serum amyloid A

A healthy endothelium provides for an antiadhesive/antithrombogenic surface, which can prevent the development of atherosclerosis and thrombosis. Patients with inflammatory rheumatic diseases have a higher incidence of cardiovascular diseases compared to the general population. This is partly due to the presence of chronic inflammation, a proven risk factor for the development of atherosclerosis. Serum amyloid A (SAA) is an acute phase protein upregulated in sera of patients with inflammatory rheumatic diseases, shown to activate endothelial cells. Our research aim was to characterize whether medications used by patients with inflammatory rheumatic diseases can influence the inflammatory/procoagulant responses of human coronary artery endothelial cells activated by SAA. For this purpose, we used cultures of primary cells and the following drugs: dexamethasone, methotrexate, certolizumab, captopril, etanercept, etoricoxib, rosiglitazone, meloxicam, fluvastatin and diclofenac. We found that fluvastatin and methotrexate successfully inhibited inflammatory activation and may thus also slow down the development of atherosclerosis and cardiovascular diseases. On the other hand, the influence of nonsteroidal antiinflammatory drugs showed more diverse responses. Encouragingly, none of the drugs significantly lowered the viability of the studied cells.

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Prof. dr. Snezna Sodin-Semrl, University Medical Center Ljubljana [snezna.sodin@kclj.si](mailto:snezna.sodin@kclj.si)



Source: K. Lakota, D. Hrušovar, M. Ogrič, K. Mrak-Poljšak, S. Čučnik, M. Tomšič, B. Božič, P. Žigon, and S. Sodin-Semrl; Analysis of Drug Effects on Primary Human Coronary Artery Endothelial Cells Activated by Serum Amyloid A; Mediators of Inflammation, Volume 2018.

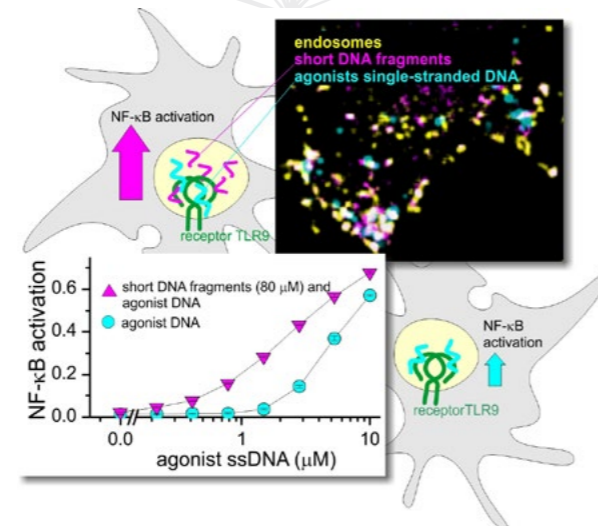
Hyperlink: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5833471/pdf/MJ2018-8237209.pdf>

**Prof. Dr. Mojca Benčina**

Short single-stranded DNA degradation products augment the activation of Toll-like receptor

Bacterial and viral infections trigger activation of immune response and prime the host protection against infections. Toll-like receptors, as pattern recognition receptors, are critical for the recognition of prototypical molecules characteristic of microbes, among which Toll-like receptor 9, TLR9, recognizes DNA fragments of bacteria and viruses. We discovered that the very short DNA fragments that are constantly present in the body strengthen the immune response to bacterial DNA. The presence of short DNA fragments is crucial especially when the extent of bacterial infection is limited and the infection itself does not trigger the immune response. We have shown that in addition to longer DNA fragments, TLR9 receptor binds short DNA fragments that significantly enhance the immune response. This is important for understanding the functioning of the immune response against pathogens and for potential use in immunotherapy. Discovery can significantly change the preparation of modern vaccines.

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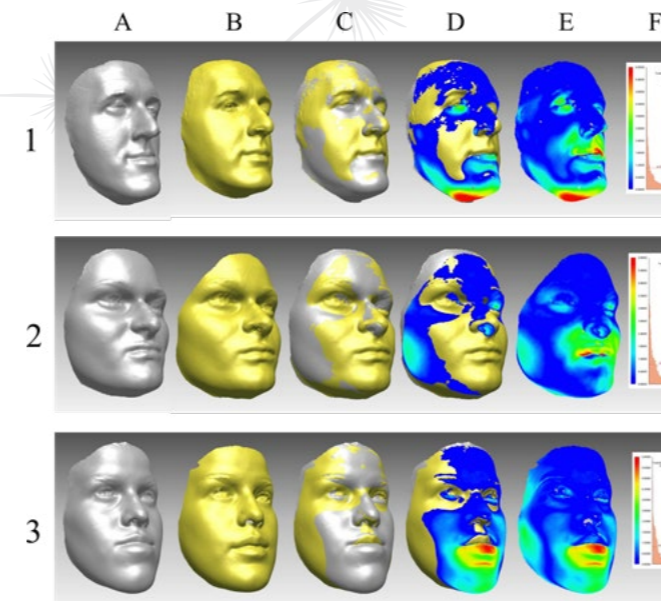
Source: Pohar J, Lainšček D, Ivičak-Kocjan K, Cajnko MM, Jerala R, Benčina M. Short single-stranded DNA degradation products augment the activation of Toll-like receptor 9; Nature communications 8: 15363 (2017).

Hyperlink: <https://www.nature.com/articles/ncomms15363>

**Prof. Dr. Nataša Ihan Hren**

Three-dimensional facial changes after skeletal changes in dentofacial deformities

Dentofacial deformities of skeletal Class III correct surgically with movements of facial skeleton in position, which allows good occlusion as demanded for normal orofacial functions, such as biting, chewing, speaking, breathing and normal function of temporomandibular joints. Consequently, bone movements cause significant changes in facial soft tissues and affect facial aesthetics. Our study has shown the coefficients of changes in facial soft tissues as a result of facial bone movements in dentofacial deformities of skeletal Class III. By comparing 3-dimensional scans of facial soft tissue before and 6 months after surgery with 3 different surgical treatments, we described changes of soft tissues in correlation with bone movements of the jaws in the sagittal plane. Facial soft tissues follow unequally the facial skeleton, and differently in particular facial regions.



Because of this, we divided face into several regions. Facial soft changes as a consequence of bone changes were calculated (coefficients as proportions) separately for different face regions. Regarding bone movements, the changes take place in a wide and varied range, and the maximum coefficients are only 50% of bone sagittal changes. This behaviour enables a more predictable planning of facial changes following surgical corrections. The skeletal Class III dentofacial deformities are the most frequently surgically treated orthognathic disorders in Slovenia. Differing in prevalence, these deformities are a problem in many ethnic groups of all races. The standard diagnostics and follow-up after the treatment are based on bone markers. Nowadays, facial aesthetics significantly influences individual psychosocial functioning in society, which is why the objective knowledge of facial changes as a consequence of such treatment is very important and already affects our planning of surgical procedures. The published results are the first in well-known literature to describe three dimensional changes of the whole face. Our results are part of the objective knowledge that will lead to the inverse planning of such procedures in the future.

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Source: VERDENIK, Miha, IHAN HREN, Nataša. Three-dimensional facial changes correlated with sagittal jaw movements in patients with class III skeletal deformities. British journal of oral & maxillofacial surgery, ISSN 0266-4356, 2017, vol. 55, iss. 5, pp. 517-523.

Hyperlink: [https://www.bjoms.com/article/S0266-4356\(17\)30059-1/abstract](https://www.bjoms.com/article/S0266-4356(17)30059-1/abstract)

## Dr. Zala Lužnik

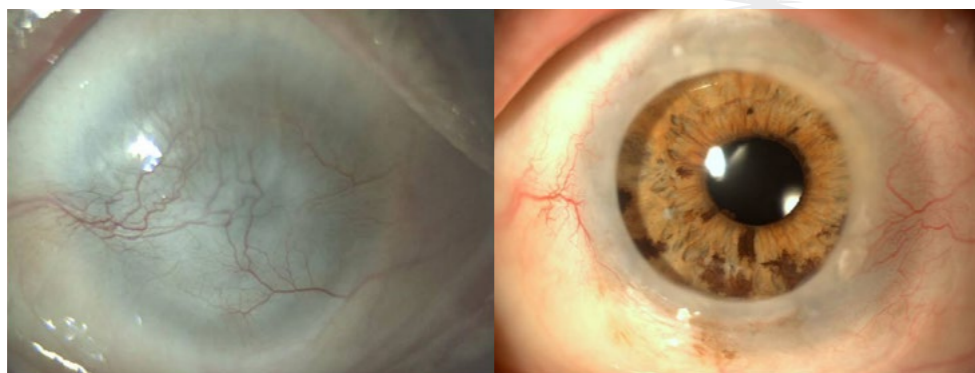
Identification and characterization of dendritic cell subtypes in preserved and cultured cadaveric human corneolimbal tissue on amniotic

Corneal dendritic cells (DC) and their maturation play a key role in the development of corneolimbal allograft rejection. There are two main subtypes of DC: myeloid (mDC) and plasmacytoid (pDC), with different biological properties. While the major role of mDC is initiation of allograft rejection, pDC play an important role in immune tolerance, in other words, for host allograft acceptance. The identification of human cornea pDCs has not yet been reported thus far.

The purpose of our study was to determine the content and distribution of different subtypes of DC in preserved human corneolimbal tissue and to compare the results with limbal explant cultures on amniotic membrane. This is the first published study that has identified pDC in cultured and preserved (non-cultured) human corneolimbal tissue. In addition, we identified corneal stem cells positive for ABCB5 marker expression that might play

a role in limbal graft function preservation. These findings may significantly contribute to the optimization of preparation of cultured limbal allografts, which will have optimal immunological properties and a suitable stem cell content for the treatment of patients with advanced ocular surface diseases. The success of corneal transplantation is very high when the donor corneas are transplanted into uninflamed recipient corneal beds. Success is greatly reduced when the donor corneas are transplanted into inflamed and highly vascularized recipient eyes. The discovery of potentially tolerogenic pDC in human corneas is an important contribution to a better understanding of the immunobiology of the eye, and may enable new treatment options to prevent corneal allograft rejections.

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Eye before and after corneal limbal epithelial stem cell transplantation (surgeon: as. dr. Petra Schollmayer)

Source: Lužnik Z, Kopitar AN, Lapajne L, Pižem J., Ferrari S, Ihan A, Hawlina M, Schollmayer P. Identification and characterization of dendritic cell subtypes in preserved and cultured cadaveric human corneolimbal tissue on amniotic membrane. *Acta Ophthalmologica*. 2018 In Press

Hyperlink: <https://onlinelibrary.wiley.com/doi/10.1111/aos.13854>

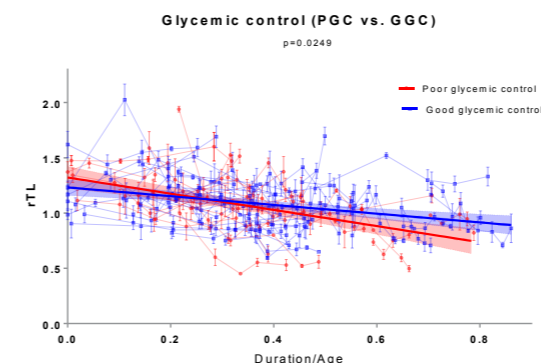
## Prof. Dr. Katarina Trebušak Podkrajšek, Prof. dr. Tadej Battellino

Association of glycaemic control and cell stress with telomere attrition in type 1 diabetes

Researchers of the Medical Faculty in Ljubljana and University Children's Hospital, UMC Ljubljana, coordinated by assoc. prof. Katarina Trebušak Podkrajšek and prof. Tadej Battellino had been studying the dynamics of telomere attrition in paediatric patients with type 1 diabetes in relation to the success of their blood glucose management. The results showed accelerated telomere length (rTL) shortening affected by the duration of T1D and poor glycaemic control, along with increased levels of cell stress. This process begins early after the onset of the disease, leading to accelerated cell ageing, thereby contributing to the development of T1D complications. Once again, this emphasizes the importance of appropriate T1D management from the T1D onset, since telomere length cannot be regenerated. For the first time it was shown at the molecular level that the quality of T1D management directly influences the integrity of genetic material, which is crucial for long-term maintenance of health.

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Prof. dr. Tadej Battellino, Medical Faculty, University of Ljubljana, University Medical Centre Ljubljana  
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Source: Tesovnik T, Kovač J, Hovnik T, et al. Association of Glycemic Control and Cell Stress With Telomere Attrition in Type 1 Diabetes. *JAMA Pediatr*. 2018;172(9):879-881. doi:10.1001/jamapediatrics.2018.1175

Hyperlink: <https://jamanetwork.com/journals/jamapediatrics/article-abstract/2685287>

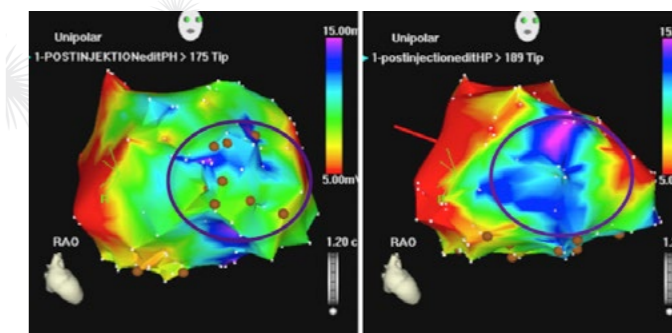
## Prof. Dr. Bojan Vrtovec

Effects of repetitive cell therapy in patients with chronic heart failure

The prevalence of chronic heart failure is steadily increasing and despite the recent advances in heart failure management, a substantial number of patients progress to the advanced stage of the disease, which is associated with very high mortality rates. There is increasing pre-clinical evidence suggesting that cell therapy is associated with improved myocardial perfusion and recovery of heart function in heart failure. Thus, the aim of our project was to investigate the clinical effects of repetitive cell therapy in patients with chronic heart failure. In all patients, stem cells were mobilized, collected from peripheral blood and injected in the target areas of the heart, guided by the use of electroanatomical mapping. Within 1 year after the cell therapy, we observed a significant improvement in the heart function, exercise capacity and laboratory markers of heart failure. This is the first randomized study to-date investigating the effects of repetitive cell therapy. The results of our study suggest that repetitive cell therapy is feasible and safe, and may represent a novel, effective treatment strategy for patients with chronic heart failure.

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Electroanatomical map of the heart before cell injection (left panel), and 6 months thereafter (right panel). There is a significant increase in myocardial viability at the sites of cell injections (blue area).



Source: VRTOVEC, Bojan, POGLAJEN, Gregor, SEVER, Matjaž, ZEMLJIČ, Gregor, FRLJAK, Sabina, CERAR, Andraž, ČUKJATI, Marko, JAKLIČ, Martina, ČERNELČ, Peter, HADDAD, François, WU, Joseph C. Effects of repetitive transcatheter CD34+ cell transplantation in patients with non-ischemic dilated cardiomyopathy. *Circulation research*, ISSN 0009-7330, 2018, vol. 123, iss. 3, pp. 389-396.

Hyperlink: <https://www.ahajournals.org/doi/abs/10.1161/circresaha.112.276519>



**Prof. Dr. Tamara Lah Turnšek, Dr. Barbara Breznik**

Mesenchymal stem cells contribute to the progression of brain tumours

Despite the achievements of modern medicine, the most common brain tumour, glioblastoma, remains incurable. The characteristics of glioblastoma are rapid growth and spread into the surrounding brain tissue as well as resistance to therapy. Today, we increasingly become acquainted with the importance of cancer cell interactions with noncancerous cells, such as mesenchymal stem cells that become part of the tumour during tumour growth and form tumour microenvironment. Mesenchymal stem cells reside in various tissues for the regeneration of damaged tissues. Similarly, these cells also migrate into brain tumours, mostly from the bone marrow through the blood. We have proven that mesenchymal stem cells are localized together with glioblastoma cells in the peri-vascular regions. Cells intensely communicate with each other through various signalling pathways, for example via B1 receptor and various types of cytokines, thereby affecting the growth and invasiveness of the cells, as demonstrated in our publications. These interactions affect the activity of various pro-invasive proteolytic enzymes - cathepsins, as demonstrated by

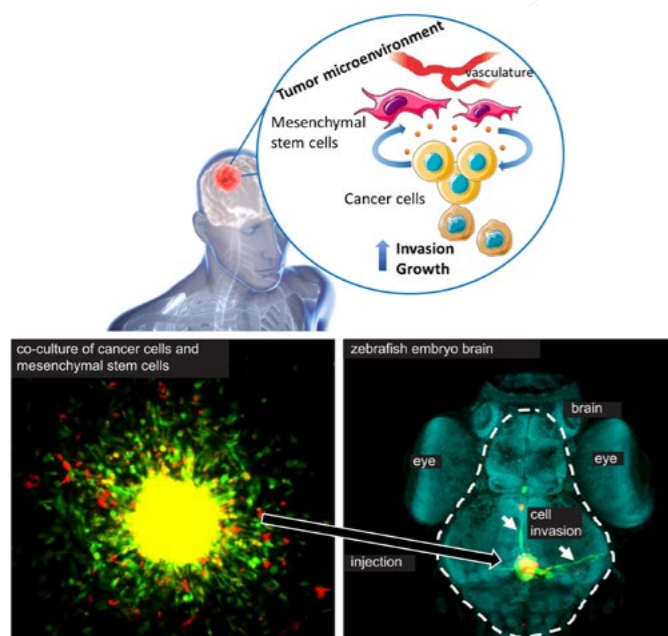
their selective inhibitors. The most surprising is our discovery that cellular communication depends on the type and properties of the glioblastoma cells, as the mesenchymal stem cells increase the invasion of one subtype of glioblastoma cells and inhibit the invasion of cells of other subtypes. The results were also confirmed in the animal zebrafish model, as their brain mimics the microenvironment of brain tumours in humans. Taken together, we demonstrated the key effects of mesenchymal stem cells in the glioblastoma progression and that mesenchymal stem cells and cellular interactions in brain tumours can be targets for new anti-cancer agents.

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**Dr. Barbara Breznik, National Institute of Biology** [barbara.breznik@nib.si](mailto:barbara.breznik@nib.si)

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BREZNIK, Barbara, MOTALN, Helena, LAH TURNŠEK, Tamara. Proteases and cytokines as mediators of interactions between cancer and stromal cells in tumours. *Biological chemistry*, ISSN 1431-6730, 2017, vol. 398, p. 7, pp. 709-719, doi: 10.1515/hsz-2016-0283.

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<https://www.ncbi.nlm.nih.gov/pubmed/28424417>  
<https://www.ncbi.nlm.nih.gov/pubmed/28938624>  
<https://www.degruyter.com/view/j/bchm.2017.398.issue-7/hsz-2016-0283/hsz-2016-0283.xml>



**Prof. Dr. Marko Noč, Assist. Prof. Dr. Tomaž Goslar**

Coronary artery revascularization strategy in patients with cardiogenic shock after myocardial infarction

Culprit-Shock study was the biggest randomized study performed in patients with myocardial infarction complicated by cardiogenic shock. In the time period of 4 years (between April 2013 and April 2017), 706 patients from 11 European countries and 80 hospitals were randomized. The study investigated what is the best revascularization approach in patients with myocardial infarction complicated by cardiogenic shock: revascularization of culprit only coronary artery or complete revascularization?

The results showed superiority and better survival also after a year of follow up of patients with culprit only revascularization strategy. The published one year follow up only confirmed survival benefit after 30 days that was published last year.

As a result of this study, the European society of cardiology guidelines on myocardial revascularization of patients with myocardial infarction complicated by cardiogenic shock has already been changed.

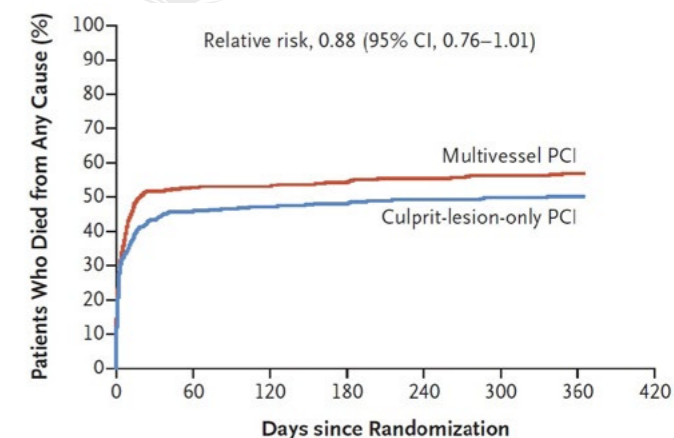
The study was funded by European Union under the 7TH framework programme. We have lost further research programme funding from the Slovenian Research Agency.

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**Assist. Prof. Dr. Tomaž Goslar, Medical faculty, University of Ljubljana** [tomaz.goslar@gmail.com](mailto:tomaz.goslar@gmail.com)

Sources: Thiele H, Akin I, Sandri M, de Waha-Thiele S, Meyer-Saraei R, Fuernau G, Eitel I, Nordbeck P, Geisler T, Landmesser U, Skurk C, Fach A, Jobs A, Lapp H, Piek JJ, Noc M, Goslar T, Felix SB, Maier LS, Stepinska J, Oldroyd K, Serpytis P, Montalescot G, Barthelemy O, Huber K, Windecker S, Hunziker L, Savonitto S, Torremante P, Vrints C, Schneider S, Zeymer U, Desch S. One-Year Outcomes after PCI Strategies in Cardiogenic Shock. *N Engl J Med*. 2018 Nov 1;379(18):1699-1710.  
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<https://www.ncbi.nlm.nih.gov/pubmed/29083953>



No. at Risk								
Multivessel PCI	341	161	160	156	152	149	131	
Culprit-lesion-only PCI	344	186	181	178	174	172	147	

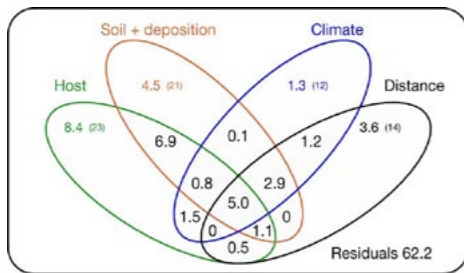
**Dr. Tine Grebenc**

Environmental factors and host as large-scale controls of ectomycorrhizal fungi

Explaining the large-scale diversity of soil organisms that drive biogeochemical processes and their responses to environmental change is critical. However, identifying consistent drivers of belowground diversity and abundance for some soil organisms at large spatial scales remains problematic. Here, we investigate a major guild, the ectomycorrhizal fungi, across European forests at a spatial scale and resolution that is to our knowledge unprecedented, to explore key biotic and abiotic predictors of ectomycorrhizal diversity and to identify dominant responses and thresholds for change across complex environmental gradients. We show the effect of 38 host, environment, climate and geographical variables on ectomycorrhizal diversity, and define thresholds of community change for key variables. We quantify host specificity and reveal plasticity in functional traits involved in soil foraging across gradients. We conclude that environmental and host factors explain most of the variation in ectomycorrhizal diversity, that the environmental thresholds used as major ecosystem assessment tools need adjustment and that the importance of belowground specificity and plasticity has previously been underappreciated.

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*Contribution shares of variables in clarifying the distribution of ectomycorrhizal fungi communities (above) and the analysis of indicator values of ectomycorrhizal fungi genera, and the relation with environmental factors (below).*



Source: Sietse van der Linde, et al., (2018). Environment and host as large-scale controls of ectomycorrhizal fungi. Nature 558, 243-258.

Hyperlink: <https://www.nature.com/articles/s41586-018-0312-y>

**Assist. Prof. Dr. Maša Vodovnik**

Valorisation of deinking sludge by fungal production of lignocellulolytic enzymes

Disposal of waste sludges produced in large amounts in the pulp and paper industry imposes significant environmental and economic problems. One strategy to address these issues involves revalorization of paper mill sludges by their application as substrates for microbial production of biotechnologically relevant enzymes. In the following work, deinking sludge was assessed as a substrate for low-cost production of lignocellulolytic enzymes by 30 selected fungal strains. Based on the results of growth and activity screenings, *Pleurotus ostreatus* PLAB was chosen as the most promising candidate, and its secretome was further studied by quantitative enzyme assays and mass spectrometry. While endoglucanase and xylanase activities detected in *P. ostreatus* enzyme extracts from cultures grown on deinking sludge were similar to activities of cultures grown on other lignocellulosic substrates, average laccase activity was significantly higher (46 000 U/kg DIS). Mass spectrometry identification of the most prominent proteins in the secretome of the target strain confirmed that significant amounts of the enzymes involved in lignin degradation (laccases, manganese peroxidase and bilirubin oxidase) were produced with this substrate despite its low lignin content indicating the presence of other inducible compounds. The findings of this study suggest deinking sludge may represent a good substrate for low-cost fungal production of aforementioned enzymes with broad biotechnological applications, including bioremediation, and paper and bioenergy industries.

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Source: VODOVNIK et al., Valorisation of deinking sludge as a substrate for lignocellulolytic enzymes production by *Pleurotus ostreatus*. Journal of cleaner production, ISSN 0959-6526. [Print ed.], 2018, vol. 197, part. 1, p. 253-263.

Hyperlink: <https://www.deepdyve.com/lp/elsevier/valorisation-of-deinking-sludge-as-a-substrate-for-lignocellulolytic-dkUdkKrV86>

**Prof. Dr. Domen Leštan**

Remediation of toxic metals contaminated soils

Ubiquitous pollution of the world's soils with toxic metals is recognized as one of the most urgent problem of environmental and human health. In Slovenia, the Meza Valley and the district of Celje are the most contaminated areas. Soil remediation and safe reuse is a solution, and feasible technologies were long sought. New, patented remediation technology (ReSoil) as the first in world enables economical, efficient and environmentally safe removal of lead, cadmium and other hazardous metals from contaminated soil. The active reagent and process waters are recycled in a closed process loop, there are no harmful emissions in the surroundings, and the cleansed soil is unharmed and remains fertile. In cooperation with the University of Ljubljana and companies Envit and Arhel, the ReSoil technology was scaled-up into the demonstrational remediation plant in the city of Prevalje in the Meza Valley. Studies on demonstrational gardens showed that soil remediation mitigates human health risk and enables the production of safe food.

Prof. Dr. Domen Leštan, Biotechnical Faculty, University of Ljubljana [domen.lestan@bf.uni-lj.si](mailto:domen.lestan@bf.uni-lj.si)



Source: LEŠTAN, Domen, FINŽGAR, Neža, GERL, Mariko, GLUHAR, Simon, LAKOVIČ, Gorazd, HAMITI, Branko. Method for soil and sediment remediation: EP 3153246 B1, 2018-05-09. Munchen: EPO, 2018. 23; patent family: Int. appl. no.: 16188935.7; GB2543076 (A), 2017-04-12; US2017100755, (A1) 2017-04-13; CN107096789 (A), 2017-08-29; CA2942367 (A1), 2017-04-07.

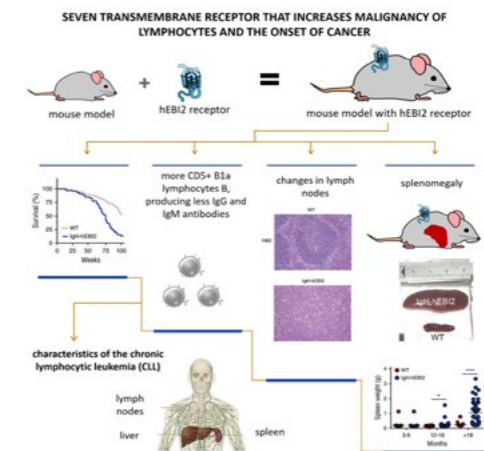
Hyperlink: <https://patents.google.com/patent/US10124378B2/en?assignee=Envit&ooq=Envit>

**Assist. Prof. Dr. Valentina Kubale Dvojmoč**

Seven-transmembrane receptor that increases malignancy of lymphocytes and the onset of cancer

With the University of Copenhagen, Denmark, we have participated in a fundamental study of the seven-transmembrane receptor. 7TM-Rs are extremely important in cell signalling and for majority of the functions in the organism. Nearly half of the drugs we use are binding to these receptors. If we know the receptor that plays a role in the development of a particular cancer, we have the opportunity and the ability to find a medicine that affects its function and thus the development of cancer. EB12 plays an important role in the increase in the number of certain types of B1 lymphocytes and the onset of chronic lymphocytic leukaemia (CLL), which is the most common adulthood leukaemia in which mature and dysfunctional B1 lymphocytes are spread. Many animal models are helpful in understanding the pathogenesis of the disease. In our model, the EB12 receptor was overexpressed in mice. The study showed that EB12 plays an important role in reducing the immune response of the B cells and up-regulation of cellular oncogenes, initial stages of cancer and premature deaths.

Assist. Prof. Dr. Valentina Kubale Dvojmoč, Veterinary Faculty, University of Ljubljana [valentina.kubale@vf.uni-lj.si](mailto:valentina.kubale@vf.uni-lj.si)



Source: Niss Arfelt K et al. EB12 overexpression in mice leads to B1 B cell expansion and chronic lymphocytic leukemia - (CLL) - like B cell malignancies. Blood 2017; 129 (7): 866-878.

Hyperlink: <https://www.ncbi.nlm.nih.gov/pubmed/28003273>

**Prof. Dr. Roman Jerala**

Protein-origami cages that self-assemble in living cells

Proteins are the most complex nanostructures that perform key processes necessary for sustaining life. They are built as a linear chain of amino acids which encodes information about the spatial structure and their function. Researchers at the Department of Synthetic Biology and Immunology at the National Institute of Chemistry have invented a method that enables design of arbitrary protein cages that self-assemble from concatenated chain of modules consisting of coiled-coil helices, which enables the formation of the designed shape. The method was named "coiled-coil protein origami" after the Japanese art of paper folding. A computer platform was developed for the design of selected protein polyhedra. Researchers have designed and characterized three types of CC protein cages: a tetrahedron, a square pyramid and a triangular prism. The latter is by far the largest artificially designed protein from a single chain and contains more than 700 amino acid residues. Researchers have shown that the cages correctly fold in bacteria, mammalian cells and animals, without causing inflammation or other adverse side effects. Using a variety of biophysical and structural techniques including SAXS and electron microscopy (EM), the structure of the cages was shown to agree well with the design models. The sides of the cages are approximately 5 nm in size. These protein cages represent a new type of protein folding that does not appear naturally in nature and has many potential applications such as in cargo delivery, enzyme encapsulation, efficient vaccine design, chemical catalysis, design of smart nanomaterials and biosensor construction.

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Source: Ajasja Ljubetič, Fabio Lapenta, Helena Gradišar, Igor Drobnač, Jana Aupič, Žiga Strmšek, Duško Lainšček, Iva Hafner-Bratkovič, Andreja Majerle, Nuša Krivec, Mojca Benčina, Tomaž Pisanski, Tanja Čirkovič Veličkovič, Adam Round, José María Caraz, Roberto Melero, Roman Jerala. Nature Biotechnology (2017) 35, 1094-1101

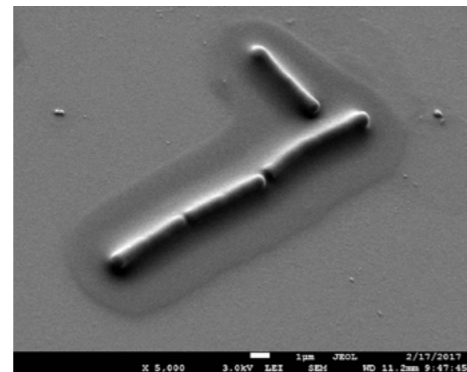
Hyperlink: <https://www.nature.com/articles/nbt.3994>

**Prof. Dr. David Stopar**

Invisible bacterial networking in dilute bacterial suspensions

It is generally accepted that bacteria in their natural environment either exist as uncoupled planktonic cells or physically connected cells in biofilms. With optical tweezers we have observed that planktonic cells in dilute bacterial suspensions interconnect and follow the motion of the optically trapped bacterium. By measuring viscous and elastic properties of the extracellular network, we have refuted the idea that planktonic cells are independent in dilute suspensions and move only in response to hydrodynamic forcing. The results suggest long-range mechanical coupling of neighbouring bacteria (more than 100 nm). Early network formation is due to extracellular nucleic acid release and is different from the mature biofilm network structure. The discovery of mechanical coupling is significant as it brakes with the long-standing notion of uncoupled planktonic cells in dilute bacterial suspensions, and provides a new framework for better understanding of microorganisms, their cooperation, and interactions with the environment.

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Mechanically coupled individual cells in dilute bacterial suspension of *Bacillus subtilis*.

Source: SRETENOVIĆ, Simon, STOJKOVIĆ, Biljana, DOGŠA, Iztok, KOSTANJŠEK, Rok, POBERAJ, Igor, STOPAR, David. An early mechanical coupling of planktonic bacteria in dilute suspensions. Nature communications, ISSN 2041-1723, Aug. 2017, vol. 8, p. 1-10, IF 12.124

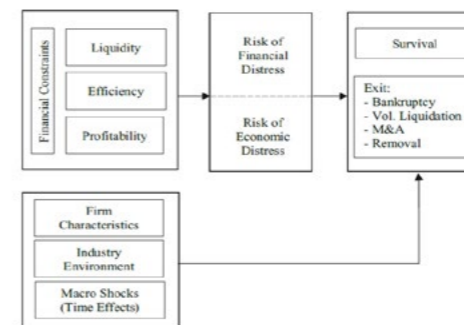
Hyperlink: <https://www.nature.com/articles/s41467-017-00295-z>

**Prof. Dr. Katja Zajc Kejžar**

The role of financial constraints for alternative firm exit modes

The paper proposes a new multidimensional instrument for measuring a firm's latent financial constraints and tests it in explaining their heterogeneous impact on different firm exit routes. Applying the proposed measure to Slovenian manufacturing and service firms over a seven-year period suggests three dimensions of firms' financial constraints, i.e. liquidity, operational efficiency and profitability. Whereas the liquidity dimension is important for court-driven and law-based exits, the efficiency dimension is critical for firms' voluntary liquidation, while profitability is for the relative likelihood of being merged or acquired. These effects of financial constraints on firm exit processes tend to be intensified during the crisis period. The results also confirm that small and medium-sized enterprises (SMEs) differ systematically from larger firms in terms of the sensitivity of the exit decision to financial constraints for all but merger and acquisition (M&A) exit routes. The results of the analysis show that an institutional framework for ensuring the efficient channeling of savings towards firms is indispensable for firm survival in general, but especially for SMEs.

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Source: Ponikvar, N., Zajc Kejžar, K. & Peljhan, D. (2017). The role of financial constraints for alternative firm exit modes. Small Business Economics

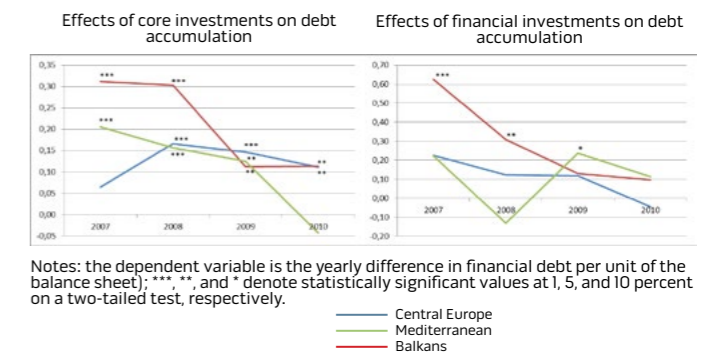
Hyperlink: <https://link.springer.com/article/10.1007%2F-s11187-017-9918-y>

**Prof. Dr. Janez Prašnikar**

Financial frictions and indebtedness of firms: Balkan countries vs. Mediterranean and Central European countries

Using a large database of financial data for non-financial corporations in the period 2006-2010, we study the process of debt accumulation and its influence on liquidity through the boom-bust-recovery regimes of the Great Recession. We show that domestic generators and amplifiers of the crisis (through the financial accelerator and collateral pricing) have much larger effects in the Balkan countries than in the Mediterranean, not to mention the Central Europe. The role of both, the capital surge from developed EU countries at the onset of the crisis and the capital reversal afterwards, should not to be ignored. Higher crisis costs in the Balkans, relative to the benchmark regions, could be attributed to the late integration of these economies into international financial and trade flows, weak financial institutions, inexperienced regulators and also misguided EU convergence doctrine. The paper is published in a renowned international economic journal (IF=1.23).

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Notes: the dependent variable is the yearly difference in financial debt per unit of the balance sheet; \*\*\*, \*\*, and \* denote statistically significant values at 1, 5, and 10 percent on a two-tailed test, respectively.

Source: Journal of Policy Modelling: a social science forum of world issues. ISSN 0161-8938. - Vol. 40, no. 4 (2018), pp. 790-809

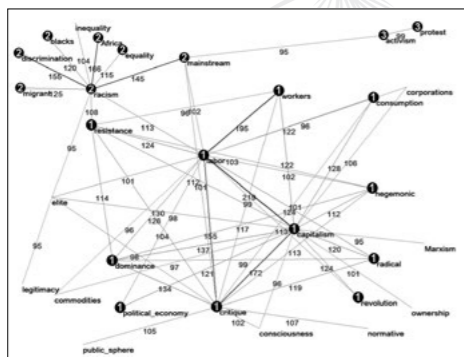
Hyperlink: [https://econpapers.repec.org/article/eeejpol-mo/v\\_3a40\\_3ay\\_3a2018\\_3aj\\_3a4\\_3ap\\_3a790-809.htm](https://econpapers.repec.org/article/eeejpol-mo/v_3a40_3ay_3a2018_3aj_3a4_3ap_3a790-809.htm)

### Prof. Dr. Slavko Splichal

Critical theory and empirical research – between exclusiveness and complementarity

Disputes over critical theory and administrative research have marked media research community for almost eight decades, but have shed little light on the issues that separate them or potentially bind them together. A network analysis of articles as clusters of interconnected concepts published in eight prominent communication journals during the period of seventy years indicates that coexistence of critical theory and empirical social inquiry is feasible. While critical approaches remain peripheral islands in communication and media research, the majority of critical articles published during the seven decades include empirical research. There are critical islands that are specific to empirical environment, distinct from those generated in the non-empirical environment, to the EU-based journals in contrast to the US-based journals, and to different historical periods, but despite major differences, the study also reveals some significant commonalities across the dominant critical currents.

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Source: Slavko Splichal, Boris Mance: Paradigm(s) Lost? Islands of Critical Media Research in Communication Journals. Journal of Communication, Volume 68, Issue 2, 1 April 2018, Pages 399–414

Hyperlink: <https://academic.oup.com/joc/article-abstract/68/2/399/4958958?redirectedFrom=fulltext>

### Assoc. Prof. Dr. Mojca Urek

Unheard voices: researching participation in social work

The article draws attention to the gap between the policies and ideology of participation on the one hand and lived experiences of participation practices in the care proceedings' systems on the other. The users' participation seems to be a trademark of contemporary EU social policy or mental health policy, while children's participation is the most emphasised part of child-friendly justice discourse, but the question arises whether they really are in place. The national and European research projects conducted by the author are used to emphasise the most problematic points, but also innovative social work and advocacy practices. The central focus of the article is the author's recent EU research project 'Access to Justice for Children with Mental Disabilities', which has addressed the participation of children with mental disabilities in all stages of the legal processes. In the case of Slovenia, these are mainly taking place at centres of social work. The findings showed that in spite of the progress towards the participation of children in general in social care decisions, children with mental disabilities remain virtually invisible.

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Photo: © UNICEF/ NYHQ2011-1059/ Holt

Source: UREK, Mojca. Unheard voices: researching participation in social work. European journal of social work: the forum for the social professions, ISSN 1369-1457, 2017, vol. 20, no. 6, p. 823-833.

Hyperlink: <https://www.tandfonline.com/doi/pdf/10.1080/013691457.2016.1278525?needAccess=true>

### Prof. Dr. Norbert Jaušovec

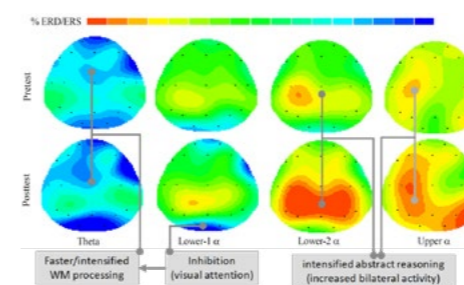
Increasing Intelligence

Increasing Intelligence overviews contemporary approaches and techniques designed to increase general cognitive ability in healthy individuals. The book covers behavioural training and different electrical stimulation methods such as TMS, tDCS, tACS, and tRNS, along with alternative approaches ranging from neurofeedback to cognitive-enhancing drugs. The monograph summarizes the history of attempts to raise intelligence. It describes the intelligence construct and the cognitive mechanisms thought to be at the core of intellectual functioning.

The sheer weight of the text is the integrated presentation of current trends in investigating intelligence that has been absent from the field for a long time. It is a valuable work for students and experts in the field of psychology, neuroscience and cognitive science. Increasing Intelligence consists of ambitious thinking and writing. It is rewarding to see so many issues related to intelligence woven into these authors' argument.

The finding that working memory training can increase fluid intelligence triggered a great number of cognitive training studies, the results of which have been fiercely debated among experts. The findings also prompted a surge of commercial versions of these working memory training programs.

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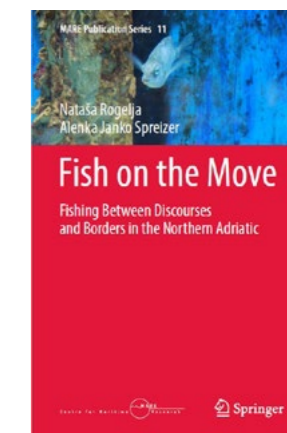
Source: JAUŠOVEC, Norbert, PAHOR, Anja. Increasing intelligence. London [etc.]: Academic Press, an imprint of Elsevier, cop. 2017. VII, 333 p., illustr. ISBN 978-0-12-809407-5.

Hyperlink: <http://www.sciencedirect.com/science/book/9780128094075>

### Dr. Nataša Rogelja Caf, Prof. Dr. Alenka Janko Spreizer

Fish on the move: fishing between discourses and borders in the Northern Adriatic

The book navigates along North Adriatic shores. This in itself is a complicated endeavour. One needs first to understand acrobatic tourist rhetoric that allows for constant transformations of turbulent conflicts into a richly-layered heritage; one needs to crack the paradox between the promotional Istrian label – multiculturalism, and a nationalist wish to preserve pure cultures framed by clearly defined borders. "Fish on the Move" analyses the relation between different discourses and actors in Northern Adriatic through an ethnographic approach and with the special emphasis on fishermen and fishing, showing not only how fishermen in Slovenia respond to changes in international political economy by struggling to survive but also how they themselves are actors of change. Fishing in the north-eastern part of the Adriatic Sea is an economic activity anchored in many stories. Regional conflicts, wars, the demise of empires and the rise of nation states with ensuing maritime border issues, socialist heritage, transnational and transformational processes in Europe, and the growth of capitalist relations between production and consumption in coastal areas, have all contributed to the specific discourses that have affected this relatively under-researched area. How this complex, layered and ambiguous negotiation is constituted at different levels and how this situation is lived and experienced by the local fishermen working along the present Slovene coast forms the core of this book.



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Source: ROGELJA, Nataša, JANKO SPREIZER, Alenka. Fish on the move : fishing between discourses and borders in the Northern Adriatic, (MARE publication series, vol. 11). Cham: Springer Nature, 2017. IX, 214 p., illustr. ISBN 978-3-319-51895-4.

Hyperlink: <https://www.springer.com/us/book/9783319518954>

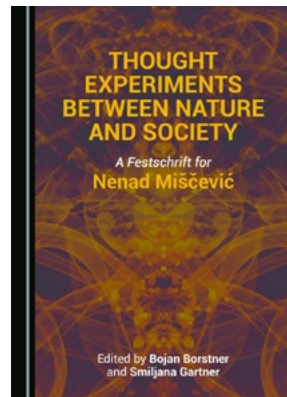
**Prof. Dr. Bojan Borstner**

Monograph: Thought experiments between nature and society. A Festschrift for Nenad Miščević

As a prominent figure in analytic philosophy of the 20th and 21st centuries, Nenad Miščević has enriched, enhanced, and expanded many areas of it. This volume, dedicated to him for his 65th birthday, follows the virtues he so much respects – conceptual analysis, rigorous use of logics, and clear definitions – and applies them to a very hot topic in philosophy – thought experiments. Present throughout the history of philosophy, thought experiments have become indispensable for the discipline and for analytic philosophy in particular. But what exactly is a thought experiment, what does it consist of, and, most importantly, is it even useful for philosophy? Next to these conceptual questions, the collection of texts in this book tackles thought experiments that have tradition, some of them very long, like the Ring of Gyges, the Social Contract, and Descartes' Evil

Demon. Others, like the Twin Earth, Brain-in-a-Vat thought experiments, and Gettier cases, have prompted at least half-a-century-long trails. One cannot understand contemporary analytic philosophy without understanding these trails and traditions.

Nenad's closest friends and colleagues from all over Europe share their thoughts on this topic, followed diligently by Nenad's comments on their work.



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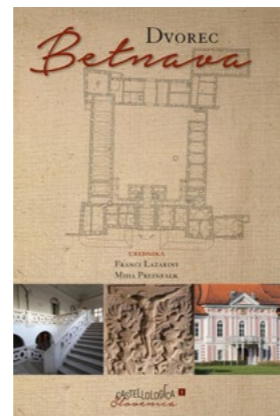
Source: BORSTNER, Bojan (urednik, avtor dodatnega besedila), GARTNER, Smiljana (urednik, avtor dodatnega besedila). Thought experiments between nature and society : a festschrift for Nenad Miščević. Newcastle upon Tyne: Cambridge Scholars, 2017. XXXVI, 437 p., illustr. ISBN 978-1-4438-8643-7. ISBN 1-4438-8643-2. [COBISS. SI-ID 23209480]

Hyperlink: <https://www.cambridgescholars.com/thought-experiments-between-nature-and-society>

**Assist. Prof. Dr. Franci Lazarini, Dr. Miha Preinfalk**

Dvorec Betnava (Betnava Manor)

The monograph Dvorec Betnava (Betnava Manor), a joint project of the France Stele Institute of Art History and Milko Kos Historical Institute ZRC SAZU, is the first scientific presentation of this highly important Slovenian manor. The book comprises eleven chapters written by experts of different research and professional backgrounds, who shed light on the history of the manor and its surroundings from the time it was first inhabited to World War II. They comprehensively present the owners of the castle, from the Lords of Auersperg to Barons of Herberstein, Counts of Khisl, Counts of Brandis and, finally, the Lavantine Diocese and the Maribor (Arch)diocese. The studies discuss the highly interesting architectural history of the manor, the protestant tombstones from the Betnava cemetery, the collection of paintings that once adorned the manor, the fate of the Betnava Manor after 1945. The book also features a catalogue of items from Betnava in the Maribor Regional Museum. The studies introduce original and novel findings on the history of



the manor and the Betnava estate, which will significantly contribute towards a better understanding of the significance of this outstanding monument of Slovenian castle heritage.

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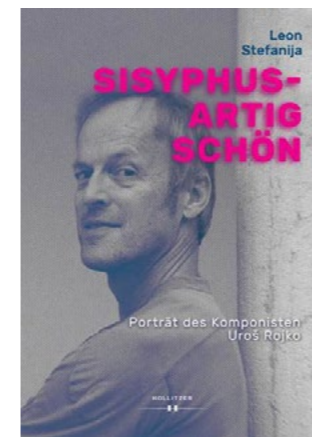
Source: Lazarini in Preinfalk: Dvorec Betnava, Ljubljana: Založba ZRC, 2018.

Hyperlink: <https://plus.cobiss.si/opac7/bib/294341888>

**Prof. Dr. Leon Stefanija**

Sisyphus-like beauty: a portrait of the composer Uroš Rojko

Uroš Rojko (1954) is a distinguished composer, clarinettist and professor of composition. He has been living and working within and between the German and Slovenian cultural spaces since the 1980s. His story is unfolded through three chapters. Chapter One – Who is Rojko? – grew from biographic fragments that Rojko completed in a comprehensive display not only of his own life: he portrayed a small fresco of the European musical culture. In the second chapter – What does Rojko do? – two voices are juxtaposed: his personal musical poetics is followed by the perception of his music by his most careful listeners, the critics (how do people understand his work?). The chapter is an analysis of Rojko's thoughts and the concepts through which his compositions have been perceived, published in an online monograph "Akademik Uroš Rojko: skladatelj o svojem delu in odzivi nanj". Chapter Three – How does he compose? – is a sketch of Rojko's compositional workshop. In sum, a concise summary of the Rojko's biography, his thoughts and criticism as well as formal analysis of his work comprising around 180 works.



The world is shaped by various processes of communication and understanding. The short 20th century has brought to music an idiosyncratic history. The book Sisyphusartig schön is a portrait of these processes through the stories of and about Uroš Rojko, a distinguished composer, clarinettist and professor of composition: it places him and his work in time and space that thoroughly questions the ways of communication and understanding.

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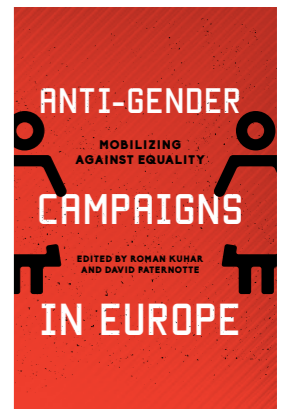
Source: Leon Stefanija: SISYPHUSARTIG SCHÖN. PORTRÄT DES KOMPONISTEN UROŠ ROJKO, Vienna: Hollitzer Verlag, 2018.

Hyperlink: <http://www.hollitzer.at/wissenschaft/programm/produktdetail/produkt/sisyphusartig-schoen-portraet-des-komponisten-uros-rojko/backPID/uebersicht-2.html>

**Prof. Dr. Roman Kuhar**

Anti-gender campaigns in Europe: mobilizing against equality

"Anti-gender campaigns in Europe" is the first comparative analysis of neo-conservative movement in Europe, which places the so-called "gender theory" or "gender ideology" at the heart of its endeavours. In the introductory chapter of the book the editors – Roman Kuhar and David Paternotte – analyse the roots of the development of this movement, its theoretical and other backgrounds that served to create the phenomenon of "gender theory", and its actors and strategies of operation. The closing chapter, which is also authored by the editors, offers a comparative analysis of the anti-gender movement in European perspective. The authors of the remaining chapters analyse national manifestations of the movement against "gender theory" in Austria, Belgium, France, Germany, Italy, Slovenia, Spain, Russia, Ireland, Poland, Croatia and Hungary. They explore how the academic concept of gender has become a tool for mobilization and the goal of social movements that have in recent years organized numerous protests, referenda and boycotts – from the biggest street protests in recent decades in France by Manif Pour Tous to forms of resistance such as e-bombing and populist use of social media. The book is, as noted by one of the reviewers, prof. Sonia Correa, "a superb cartography" of anti-gender movements, focusing on national specificities, "without losing sight of the significant transnational implications of these politics", especially in connection to the neo-conservative movements and radical right political associations.



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Source: KUHAR, Roman (urednik), PATERNOTTE, David (editor). Anti-gender campaigns in Europe: mobilizing against equality. London; New York: Rowman & Littlefield International, cop. 2017. X, 292 p., illustr. ISBN 978-1-78348-999-2.

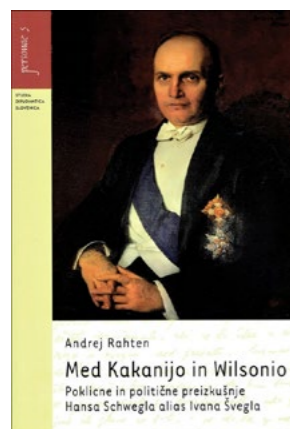
Hyperlink: <https://www.rowmaninternational.com/book/antigender-campaigns-in-europe/3-156-7734fc12-00e-3-47fc-8478-05897740ac19>

## Prof. Dr. Andrej Rahten

Scientific monograph: *Between Kakanien and Wilsonia. Professional and Political Trials of Hans Schwegel alias Ivan Švegel*

The biography, presenting the professional and political career of Ivan Švegel, a leading Slovene representative at the Paris Peace Conference and a diplomat in the Kingdom of Yugoslavia, illustrates the Slovene contribution towards the formation of the "Order of Versailles", symbolized by the name of Švegel's estate near Bled – "Wilsonia". Drawing a line under the accomplishments of Slovene representatives at the Paris Peace Conference, we may conclude that they suffered defeat in two crucial border sectors. In Carinthia, primarily for their failure to prevent the plebiscite. And in the Littoral, for just the opposite reason: Great Powers failing to heed their calls for a referendum. From the Slovene vantage point, the "Versailles system" therefore presented a double problem, with a considerable part of the Slovene ethnic territory remaining outside Yugoslavia and minorities soon becoming subject to assimilation. Besides the detailed description of Švegel's activities at the Paris Peace Conference, the monograph includes also an interesting survey of his study years at the famous Oriental Academy of Vienna and his career as Consul of "Kakanien" in

the Balkans, South Africa, United States and Canada before the First World War. Švegel's political career in the Yugoslav Kingdom was not so successful: his parliamentary and ministerial activities were namely only short-term. Even his diplomatic return as Yugoslav Royal Minister in Buenos Aires ended in disappointment. The monograph ends with a description of Švegel's destiny during the Nazi occupation and the establishment of the Communist regime in Yugoslavia.



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Source: RAHTEN, Andrej. *Med Kakanijo in Wilsonio: poklicne in politične preizkušnje Hansa Schwegla alias Ivana Švegla*. (Studia Diplomatica Slovenica, Personae, 5). 1st ed. Klagenfurt; Ljubljana; Vienna: Mohorjeva založba, 2018. 259 p., illustr. ISBN 978-3-7086-0999-7. [COBISS.SI-ID 294764800]

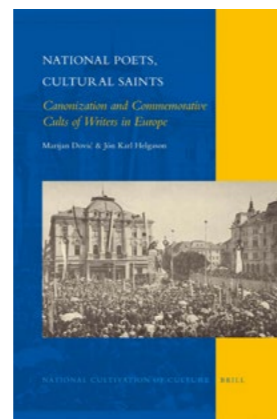
Hyperlink: <https://plus.cobiss.si/opac7/bib/nuk/294764800>

## Prof. Dr. Marijan Dovič

Monograph: *National Poets, Cultural Saints: Canonization and Commemorative Cults of Writers in Europe*

Marijan Dovič and Jón Karl Helgason (University of Iceland) published a comparative literary-historical monograph at Brill, dealing with so-called cultural saints, artists who were canonized and celebrated by European national movements since the mid-nineteenth century following the example of the worship of Christian saints. The authors develop an innovative theory that upgrades the established concept of canonization by studying ritual practices and places of memory. Taking into account the European context of cultural nationalism, they deal with the afterlives of Jónas Hallgrímsson and France Prešeren, national poets of two peripheral literatures, Icelandic and Slovenian. Prešeren's cult is analysed in the European framework with an innovative approach that links literary studies with cultural history, sociology, and anthropology. On the topic of the canonization of cultural saints, Dovič also published a highly acclaimed book *Prešeren po Prešernu* (Prešeren after Prešeren, Ljubljana: LUD Lit-

eratura, 2017) and edited the volume *Kulturni svetniki in kanonizacija* (Cultural Saints and Canonization, Ljubljana: Založba ZRC, 2016), which presents numerous additional case studies.



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Source: MARIJAN DOVIČ, JÓN KARL HELGASON. *National Poets, Cultural Saints: Canonization and Commemorative Cults of Writers in Europe*. Leiden, Boston: Brill, 2017.

Hyperlink: <https://brill.com/abstract/title/33613>

## Prof. Dr. Borut Vrščaj, Dr. Blaž Repe, Dr. Primož Simončič

The soils of Slovenia

The book gives a comprehensive view of soils in Slovenia. Apart from the geographical aspect, it provides information about history of soil research, climate, geology, geomorphology, main soil types, soil maps, soil properties, soil classification, land use and vegetation, soil management, relations between soils and humans/economy and opens questions about the future of our soils. The purpose of the book is to provide an overview of the state of Slovenian soils and a comparison in the international context. Additionally, it should serve as an important summary that can be used to direct the soil survey, soil research, data collection, and data processing towards designing sustainable soil management and better soil protection in Slovenia in the future. This book on Slovenian soils is a review of what kind, where, and how much soil is available in Slovenia; what the major threats to soils are, what the main research activities are, as well as what the status of the available soil information is. It should be borne in mind that is an important strategic and ethical question how much and what kind of soil will be left to future generations.

The publication was published as part of the World Soils Book Series (Springer publishing company). The purpose of the Series is to give a detailed overview of soils from different countries. The book is very rich with soil information and is profusely illustrated. It includes 9 main chapters, 212 figures (maps, photos and graphs), 32 tables, 242 pages and 286 sources.

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Source: VRŠČAJ, BORUT; REPE, BLAŽ; SIMONČIČ, PRIMOŽ. *Znanstvena monografija Dordrecht*: Springer, cop. 2017 English ISBN 978-94-017-8584-6 (hard bound); 978-94-017-8585-3 (e-book) COBISS.SI-ID: 5241192.

Hyperlink: <https://www.springer.com/la/book/9789401785846>

**Dr. Marija Kozar Mukič, Dr. Monika Kropelj Telban**

Monograph: Narrative Tradition of Slovenes Living in Porabje Rába-vidék Folktales and Legends on Milko Matičetov's Sound Recordings

The publication "Narrative Tradition of Slovenes Living in Porabje / Rába-vidék Folktales and Legends on Milko Matičetov's Sound Recordings" presents ethnographic and folkloristic studies of narrative culture of Slovenes living in Porabje / Rába-vidék in Hungary. The cultural heritage explored in this publication has been recorded as far back as 1970 by Milko Matičetov, and the narratives are of excellent quality which can no longer be obtained in the field.

The texts included in the publication have been transcribed from tapes in a simplified dialectal transcript, with the character sets of the usual Slovene alphabet but with the preserved vocabulary and its specific prosodic features. All of the texts are also published in the standard Slovenian language. Two narratives are also transcribed in the phonetic dialectological transcription to serve as an example.



Labritz Ferenc (Finci Feri) from Gornji Senik (photo: Mirko Ramovš 1970)

The introductory section includes studies addressing the development of the narrative culture of Slovenes in Porabje, their language and brief history, as well as a presentation of the storytellers. The folktales have been included in the international database, in accordance with the existing scientific international typology, and are therefore available for further comparative research. The main features of the Porabje dialect are highlighted as well as existing differences between individual local particularities. This section concludes with a glossary of words used in Porabje, which contributes to the preservation and documentation of the language spoken in this area.

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**Prof. Dr. Nives Kovač**

Research of microbial mat and saline mud in the hypersaline environment of the Sečovlje salina and the possibility of using saline (healing) mud for therapeutic purposes

In the past, the salt production in the northern Adriatic has had a significant impact on the economy and the life of the surrounding countries. Nowadays, the active salt production takes place only in the Piran salt pans, where the basic process is natural salt crystallization. Salt is collected on a few millimetres thick microbial mat called "petola" that covers the bottom of the crystallization basins. The thermal mud and brine are also important products, usually used in thermal tourism. Due to a lack of scientific research, three scientific works have been published making a significant contribution to the knowledge of: a) petola, its composition and roles in the processes of natural sea salt production [1]. Special attention was dedicated to the study of microbial mat compositional characteristics and functional roles in response to seasonal variation in environmental conditions, by using scanning electron microscopy. b) hypersaline sediment from the Sečovlje salt pans. The potential mobility of metals/metalloids and their biological availability

[2] and the geochemical and thermophysical properties [3], which directly influence the potential use of this sediment as a healing mud, was investigated.

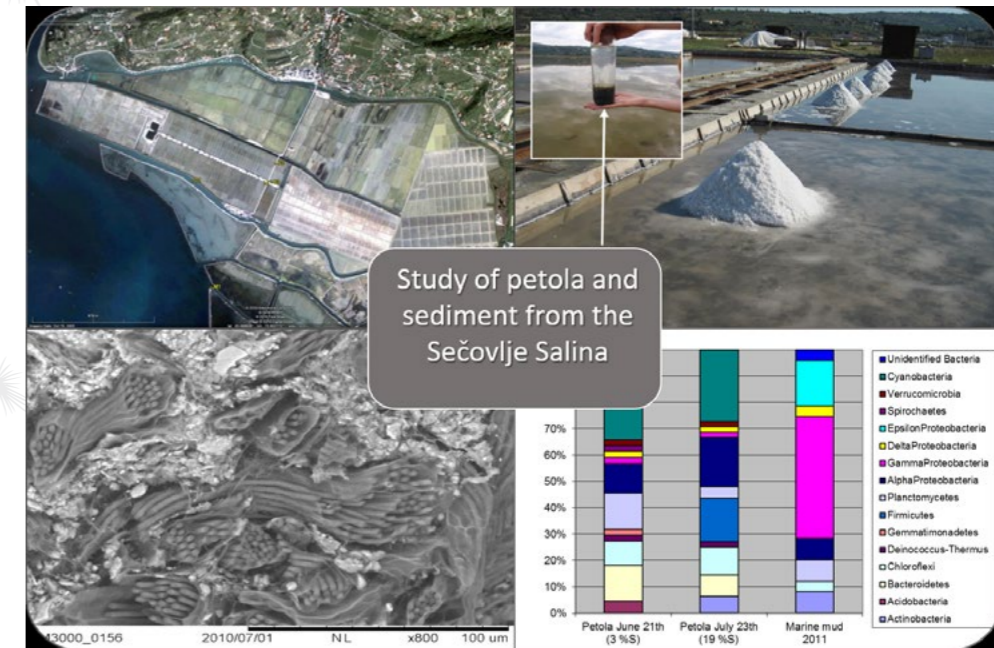
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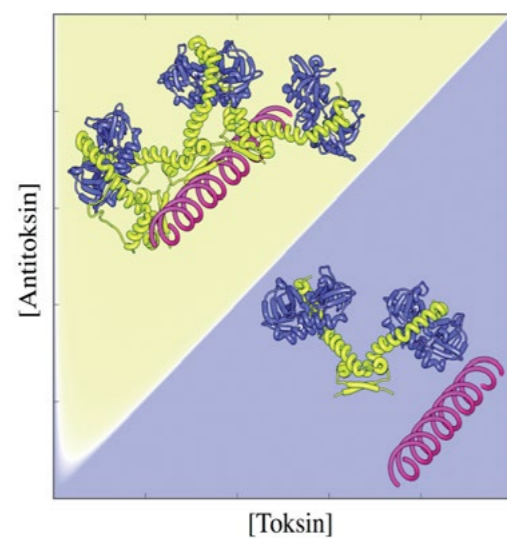
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## Prof. Dr. Jurij Lah

### Mechanism of bacterial survival in the presence of antibiotics

Survival of bacterial cells despite the presence of antibiotics causes major problems in the treatment of bacterial infections. Survival is enabled by mutations (change in genotype – resistance) or growth arrest (phenotype change) that leads bacterial cells to a “dormant” state with halted metabolism. When the concentration of antibiotics drops, the bacteria “wake up” and multiply, causing many recurrent and chronic diseases. It is known that bacterial cells can stop their metabolism by using their own genetic systems, called toxin-antitoxin modules. The results of the study explain the functioning of the modules, which depends on the regulation of transcription of genes encoding for proteins toxin and antitoxin. The regulation is described by high resolution structures of the various toxin-antitoxin complexes and the relations between them defined in terms of physical theory, thermodynamics. A detailed understanding of interactions at the molecular level enables prediction of the regulation of bacterial cell growth under stress conditions. San Hadži, Igor Drobnak, Andrej Mernik, Črtomir Podlipnik and Jurij Lah (UL FKKT), in cooperation with group of prof. Loris (Belgium), explained for the first time how and



why bacterial cells can stop their growth and development. This opens the possibility of planned interventions to control the formation of “dormant” bacterial cells. Interdisciplinary research is published in three articles in reputable international journals with an impact factor greater than ten.

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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  
2018 in accordance with the staffing  
plan: 48

Funds received from the national  
budget for scientific-research activi-  
ties in the 2018 financial year: EUR 164. 2 million

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: [www.arrs.si/en/](http://www.arrs.si/en/)