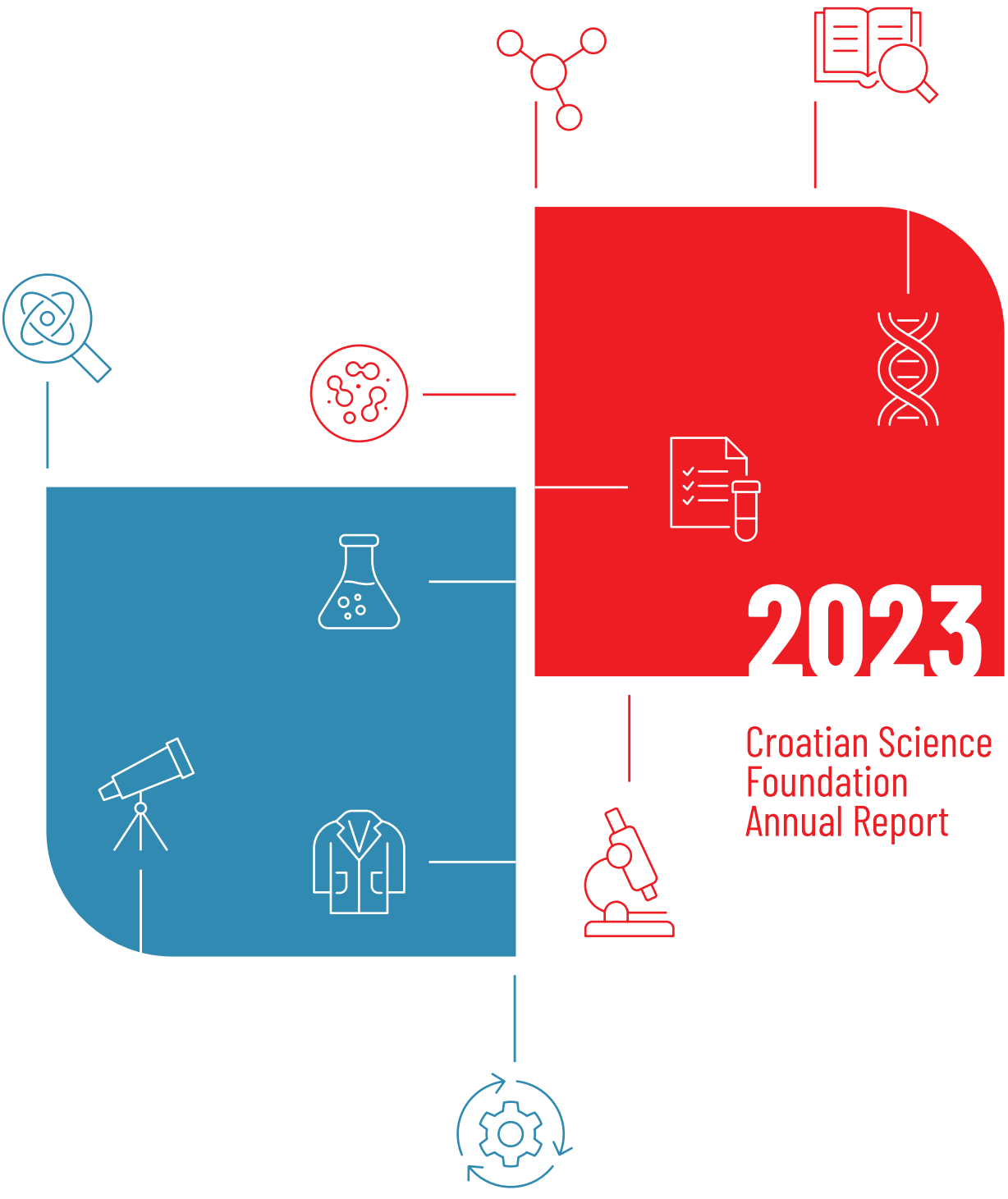
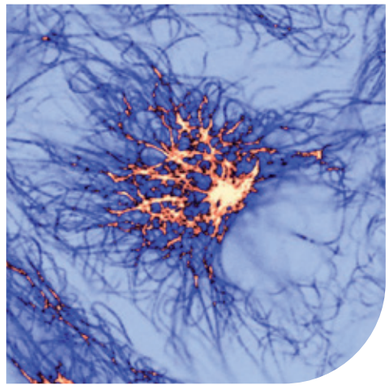
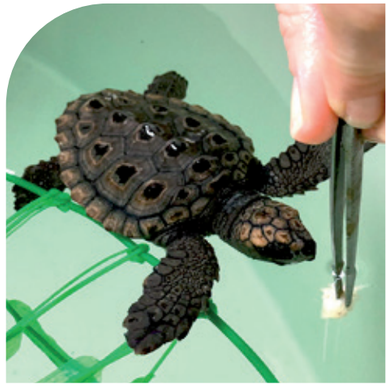
HRZZ
Croatian Science Foundation

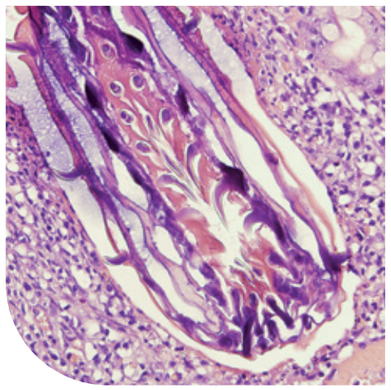


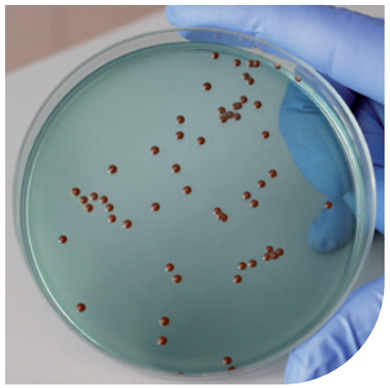
2023

Croatian Science Foundation Annual Report









Content

Opening address by Director

In 2023, the Croatian Science Foundation completely adapted to the new legislative framework, in line with the reform objectives of developing a more efficient research and innovation funding system as set out in the National Recovery and Resilience Plan (NPOO). We also spent considerable efforts on strengthening the Foundation's role in the national research and innovation system and enhancing the capacities of our employees for performing professional and administrative tasks.

In 2023, the Foundation disbursed a total of **EUR 27,719,078** for financing scientific research projects, young researchers' salaries and mobility of research assistants. The majority of funds disbursed in 2023 originated from the State Budget of the Republic of Croatia (93.86%), while other sources included ESI Funds (European Social Fund), Recovery and Resilience Facility and international collaboration (Swiss-Croatian Cooperation Programme and ERA-NET programmes).

A total of **742 projects and 869 young researchers** (research assistants and senior research assistants) were funded in 2023 through various programmes run by the Foundation. The largest portion of funds was disbursed to young researchers (EUR 12.19 million, or 43.99% of HRZZ's budget), research projects (EUR 8.70 million, or 31.37% of the budget) and installation research projects (EUR 4.70 million or 16.96% of the budget).

National funding of scientific research projects continued through our two core programmes "Research Projects" and "Installation Research Projects". The Foundation monitored the implementation of **405 research projects** in 2023, with more than **9,870 scientists** engaged in their activities, which includes PIs and team members, of which 96 are senior research assistants. We also monitored **132 installation projects**, which engage more than **1,100 scientists** (Principal Investigators and team members) in their activities, including 106 research assistants and 37 senior research assistants. We also finished the evaluation of the Call **IP-2022-10**, with **189 projects** accepted for financing. A total of **EUR 7,510,171.06** was earmarked for the first year of implementation of these projects, while their total budget for all four years amounts to **EUR 23,944,365.47** (not including salaries of senior research assistants that would be recruited to work on the projects). Through the "Young Researchers' Career Development Project – Training New Doctoral Students" we financed more than 500 research assistants (510 research assistants were in our system on 31 December 2023). Apart from the Young Researcher's Career Development Project, we also used the State Budget funds to finance research assistants that were previously funded through our other programmes (7 from CSRP, 28 from PZS and 13 through ESF).

Through the National Recovery and Resilience Plan (NPOO) we started a systematic scheme for financing mobility and international networking of junior and senior research assistants. The "Outbound mobility of research assistants" programme saw three call cycles completed, with additional cycles planned for 2024. 30 research visits of research assistants were contracted in the first two cycles, while the 26 applications submitted in the third cycle will be evaluated in early 2024. The "Outbound mobility of senior research assistants" programme saw two calls launched in 2023, with a total of 75 applications. A total of 32 senior research assistants were approved for financing through the first call (MOBODL-2023-08) and will start their research visits in early 2024. The evaluation of applications to the second call (MOBODL-2023-12) is expected to finish in spring 2024. The programme "Inbound mobility of senior research assistants" saw 46 applications submitted to two separate calls. 11 applications were evaluated positively in the first call (MOBDOL-2023-08), while applications from the second call (MOBDOL-2023-12) will be contracted in early 2024. In addition, we launched one call of the "Young Researchers' Career Development Programme - Training New Doctoral Students" to be funded from NPOO. 371 project proposals were submitted to the call, which have been sent to evaluation. This process will be completed in the first half of 2024. Furthermore, in 2023 the Foundation acted in the capacity of Implementation Body on two NPOO calls for proposals - "Development Research Support" and "Targeted Scientific Research". The two calls saw 177 and 329 submissions respectively. The evaluation process and contracting for selected projects will finish in early 2024.

The Foundation also continued its high level of international cooperation. We successfully completed two international programmes - Croatian-Swiss Research Programme 2014-2023 (CSRP) and Cooperation Programme with Croatian Scientists in Diaspora "Research Cooperability", while the programme "Promoting Excellence in Higher Education - Tenure Track Pilot Programme" is ongoing. As part of the Second Swiss Contribution to selected EU-13 countries, in cooperation with the Swiss National Science Foundation (SNSF) we started developing a new funding mechanism called Multilateral Academic Projects (MAPS). This instrument is intended for multilateral research projects with several partner countries (Switzerland, Croatia Bulgaria, Hungary, Poland and Romania), whose implementation should start in late 2024.

The Foundation also continued its participation in Weave and ERA-NET consortia. A total of 20 collaborative projects funded through the Weave initiative were implemented in 2023. In addition, two new calls were launched – one with the Swiss National Science Foundation (SNSF) as the Lead Agency and one with the Slovenian Research Agency (ARRS). Four new bilateral projects were contracted at the latter call. The Foundation also continued to provide funding to projects implemented through the BlueBio (ERA-NET Cofund on Blue Bioeconomy – Unlocking the potential of aquatic bioresources), Quantera (ERA-NET Cofund in Quantum Technologies) and Chanse (Collaboration of Humanities and Social Sciences in Europe) consortia as well as participated in their new calls. In addition, one project funded through the Trans-Atlantic Platform for Social Sciences and Humanities (T-AP) is also ongoing.

If the Croatian Science Foundation is to enhance its role as the central organization for financing scientific research and talented early-career researchers, we need to secure a stable source of national funding as well as the support of the research community. This shall be done through a competitive merit-based system by applying peer review standards and criteria that are common across Europe. We also need to strengthen the Foundation's visibility both in Croatia and Europe as an organization that finances high-quality research whose results contribute to the development of society and economy.

Prof. Ozren Polašek, PhD, MD
Director of the Foundation

Calls in 2023

Mobility Programme – Inbound mobility of senior research assistants (MOBDOL-2023-12)

Call launch date **11.9.2023.**
Call deadline **1.12.2023.**
Results published **expected in Spring 2024**

Mobility Programme – Outbound mobility of senior research assistants (MOBODL-2023-12)

Call launch date **1.9.2023.**
Call deadline **1.12.2023.**
Results published **expected in Spring 2024**

Young Researchers' Career Development– Training New Doctoral Students (NPOO-DOK-2023-10)

Call launch date **20.7.2023.**
Call deadline **7.11.2023.**
Results published **expected in Spring 2024**

Trans-Atlantic Platform for Social Sciences and Humanities - Democracy, Governance and Trust (TAP-DGT)

Call launch date **8.8.2023.**
Call deadline **6.11.2023.**
Results published **expected in mid-2024**

Research Projects – Swiss-Croatian Bilateral Projects (IPCH-2023-10)

Call launch date **27.7.2023.**
Call deadline **6.10.2023.**
Results published **expected in Spring 2024**

Support to Researchers for Applying to ERC Calls (ERC Mobility)

Call launch date **31.5.2023.**
Call deadline **Permanently open**
Results published **On a continuous basis**

CHANSE - Enhancing well-being for the future (NORFACE-2023)

Call launch date **26.5.2023.**
Call deadline **21.9.2023.**
Results published **expected in Spring 2024**

CHANSE Crisis – Perspectives from the Humanities (HERA-2023)

Call launch date **26.5.2023.**
Call deadline **21.9.2023.**
Results published **expected in Spring 2024**

Mobility Programme – Inbound mobility of senior research assistants (MOBDOL-2023-12)

Call launch date **20.4.2023.**
Call deadline **22.8.2023.**
Results published **expected in early 2024**

Mobility Programme – Outbound mobility of senior research assistants (MOBODL-2023-12)

Call launch date **20.4.2023.**
Call deadline **22.8.2023.**
Results published **expected in early 2024**

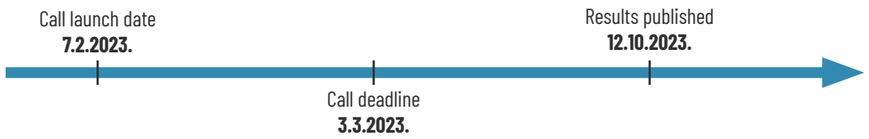
Mobility Programme – Outbound mobility of research assistants (MOBDOK-2023)

Call launch date **20.4.2023.**
Call deadline **Permanently open**
Results published **On a continuous basis**

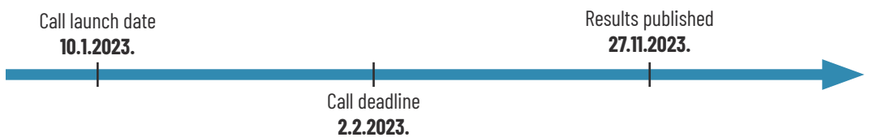
ERA-NET Cofund in Quantum Technologies (QuantERA-2023)

Call launch date **17.2.2023.**
Call deadline **11.5.2023.**
Results published **19.12.2023.**

Research Projects – Slovenian-Croatian Bilateral Projects (IPS-2023-02)



ERA-NET Information and Communication Technologies (CHIST-ERA-2022)



Research Projects (IP-2022-10)

HRZZ Organizational structure

The new Act on the Croatian Science Foundation entered into force on 28 May 2022 (Official Gazette 57/2022). Pursuant to this Act, the Foundation's bodies are the Board, Director and Complaints Committee.

The fifth assembly of **HRZZ's Board** comprises the following **members:**

Dr Slavko Perica, PhD, Tenured Scientific Adviser, Board President

Prof. Željko Kaštelan, PhD, MD, FCA, Board Vice-President

Prof. Anna-Maria Getoš Kalac, PhD, Board Vice-President

Prof. Srečko Kovač, PhD, Board member

Prof. Milan Mesić, PhD, Board member

Prof. Nikola Ružinski, PhD, Board member

Prof. Dražen Vikić-Topić, PhD, Board member

The role of **Director** is held by Prof. Ozren Polašek, PhD, MD.

HRZZ's Office for Professional and Administrative Tasks is divided into 6 offices, further divided into 11 departments and Internal Control and Audit Unit. On 31 December 2023, the Foundation had 38 employees (including 3 employees on maternity leave). All HRZZ-'s employees have full-time contracts.

HRZZ programme funding in 2023

In 2023, HRZZ disbursed a total of **EUR 27,719,078** million for financing scientific research projects, young researchers' salaries and mobility of research assistants.

In sum, from its establishment in 2001 until the end of 2023, HRZZ disbursed **EUR 219,488,265** in total for scientific projects and young researchers.

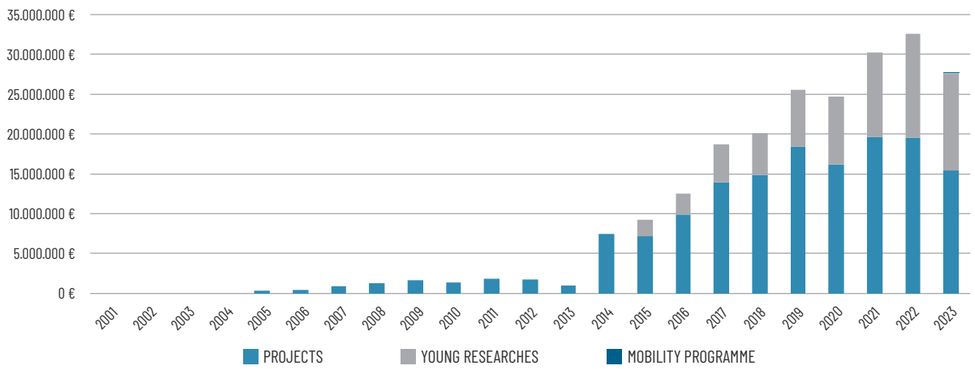


Figure 2. Annual amounts of funding for scientific research projects, young researchers and research mobility in the period 2002-2023

As in previous years, the majority of funds disbursed in 2023 originated from the State Budget of the Republic of Croatia (93.86%), while other sources included ESI Funds, Recovery and Resilience Facility and international collaboration (Swiss-Croatian Cooperation Programme and ERA-NET programmes).

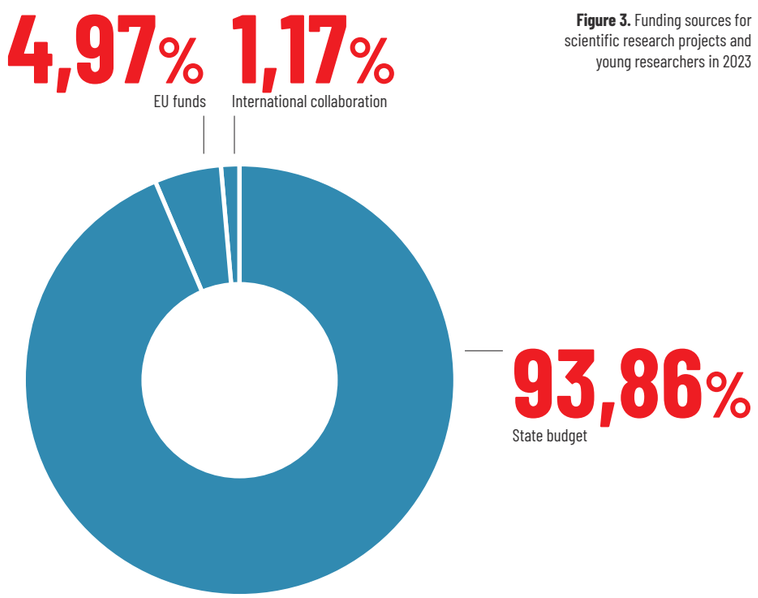
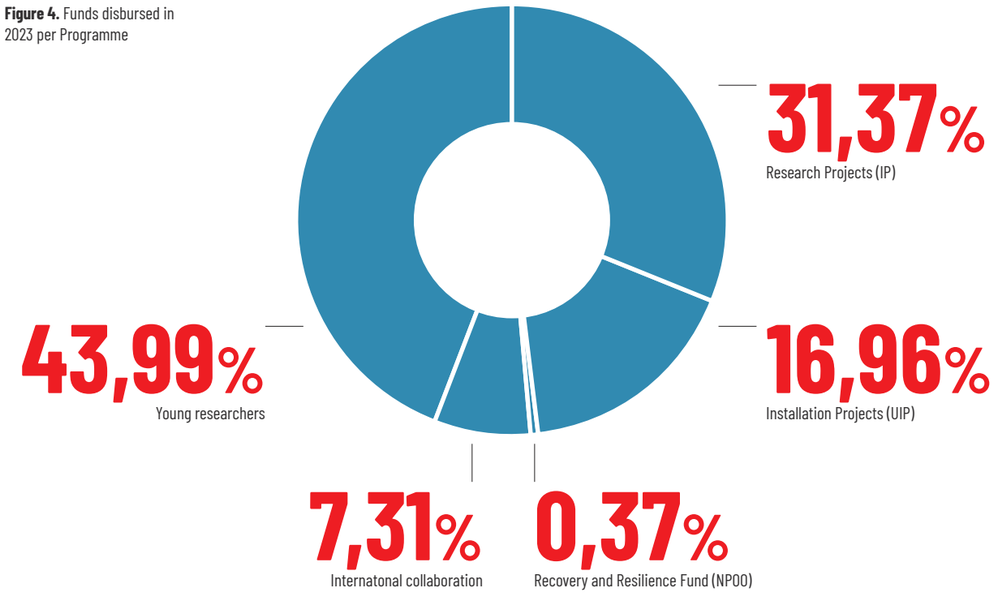


Figure 3. Funding sources for scientific research projects and young researchers in 2023

A total of 742 projects and 869 young researchers (research assistants and senior research assistants) were funded in 2023 through various HRZZ programmes. The largest portion of funds was disbursed for young researchers (EUR 12.19 million, or 43.99% of HRZZ's budget), research projects (EUR 8.70 million, or 31.37% of the budget) and installation research projects (EUR 4.70 million or 16.96% of the budget).

Figure 4. Funds disbursed in 2023 per Programme



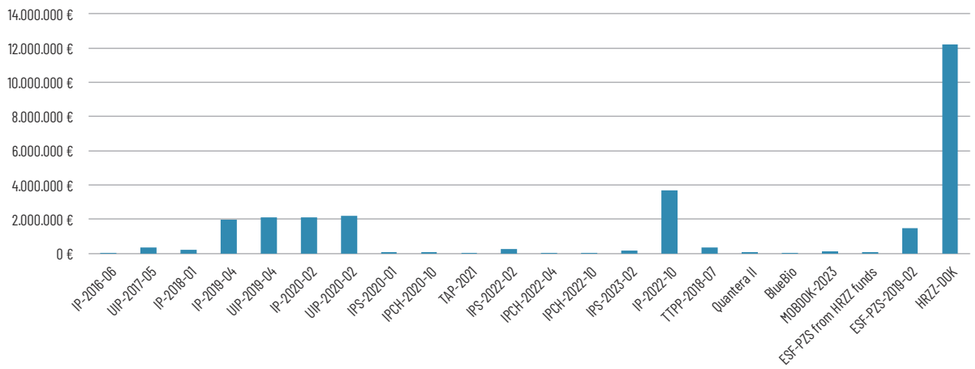
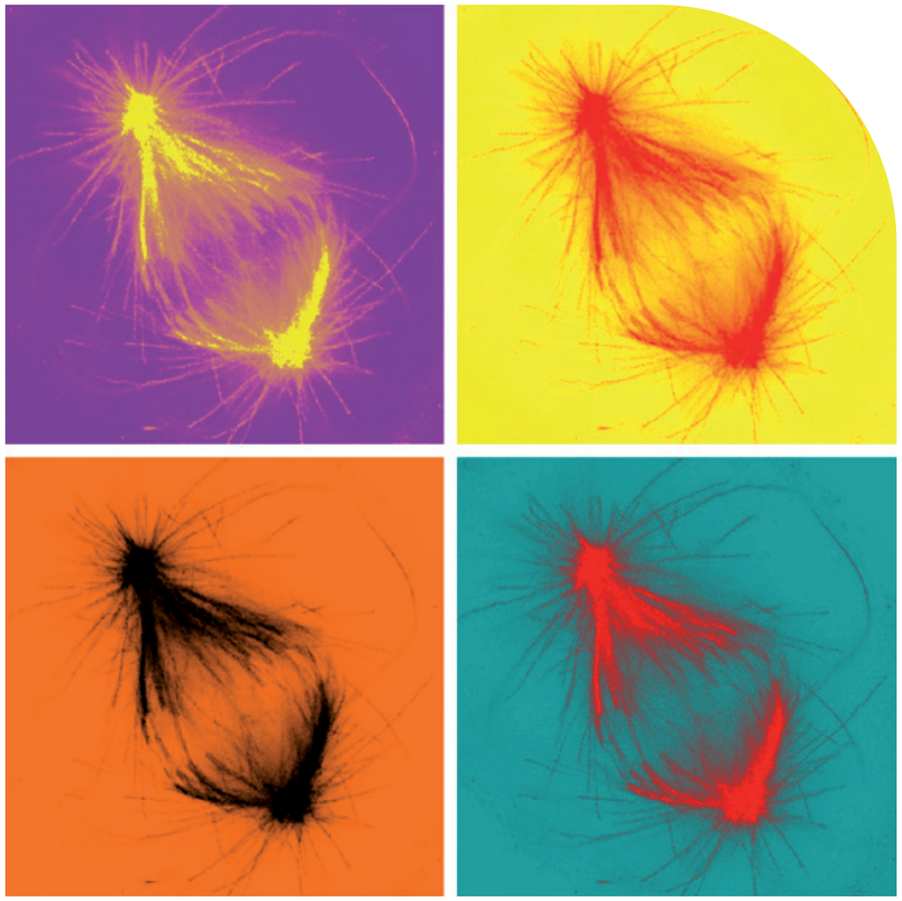


Figure 5. Programmes funded in 2023 broken down by individual calls

Young researchers are supported through the following programmes: "Young Researchers' Career Development Project – Training New Doctoral Students" (research assistants), "Installation Research Projects" (research assistants and senior research assistants) and "Research Projects" (senior research assistants). The total funds disbursed through the Young Researchers' Career Development Project in 2023 originated from Source 11 General revenues and receipts (activity "HRZZ Doctoral and post-doctoral researchers").



NATIONAL FUNDING PROGRAMMES

Research Projects

The Programme "Research Projects" (IP) has been established for funding fundamental research whose goal is creating new and enhancing existing knowledge about a specific area as well as applied research that is conducted with clear technological, economic or social aims in mind. The objective of the Programme is to stimulate and support research teams that can compete at the international level and scientists that would be able to mentor a new generation of young researchers. Research projects are based on strong research teams formed at Croatian scientific institutions and include collaboration of scientific organisations, sharing equipment and the development of young researchers' careers. The maximum duration of research projects is 48 months, and the maximum amount of funding is between EUR 132,723 and 199,084 (EUR 79,634 and 119,450 for projects in the Social Sciences and Humanities).

Funds disbursed for Programme in 2023 EUR

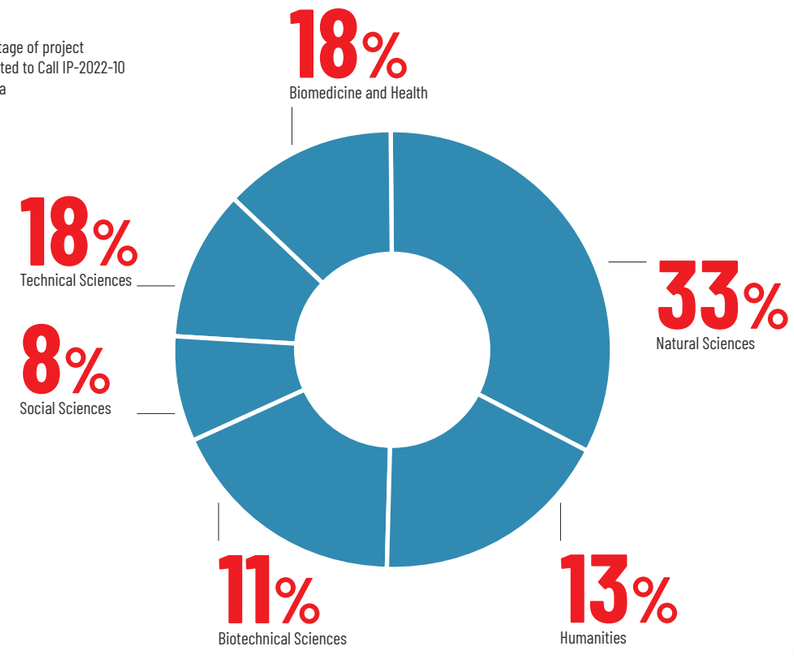
7,979,359.69

Call IP-2022-10

The Call IP-2022-10 was launched in May 2022 with 5 October 2022 set as the submission deadline. 424 project proposals were submitted to the Call.

The distribution of proposals to this Call based on the scientific areas declared by the PIs is as follows: the largest number of proposals was submitted in Natural Sciences (33%), followed by Biomedicine and Health Sciences (18%), Technical Sciences (18%), Humanities (13%), Biotechnical Sciences (11%) and Social Sciences (8%). One submitted proposal (0.2%) was classified as interdisciplinary.

Figure 6. Percentage of project proposals submitted to Call IP-2022-10 per scientific area



The Call also enabled the submission of proposals within the Weave initiative, with HRZZ assuming the role of Lead Agency for the first time, meaning that the evaluation procedure was conducted according to HRZZ's own internal procedures. A total of 53 project proposals (12.5% of all submissions) were submitted through the Weave initiative, of which 4 trilateral and 49 bilateral project proposals. Of the 49 bilateral proposals, one entails collaboration with a Swiss research team, while 48 are collaborations with Slovenian scientists.

The proposal evaluation process took up most of 2023, while the funding decision was adopted in November 2023. Of the 424 submitted project proposals, funding was approved for 189, of which 186 were contracted by the end of 2023. The remaining three were submitted through the Weave initiative (1 bilateral and 2 trilateral projects) and need to wait for approval by the partner agency, in this case SNSF. The 186 contracted projects also include four bilateral collaborations with researchers from Slovenia. A total of EUR 7.510.171,06 was earmarked for the first year of implementation of these projects, while their total budget for all four years amounts to EUR 23.944.365,47 (not including salaries of senior research assistants that would be recruited to work on the projects). The number of contracted projects and contracted first-year budgets per research institution are presented in Figure 7.

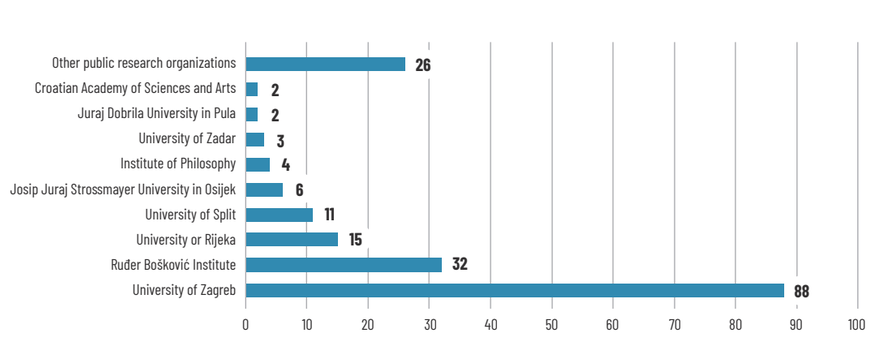


Figure 7a. The number of contracted projects per research institution, Call IP-2022-10

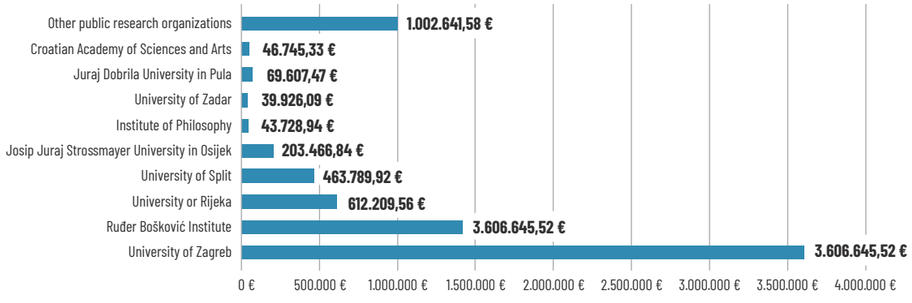
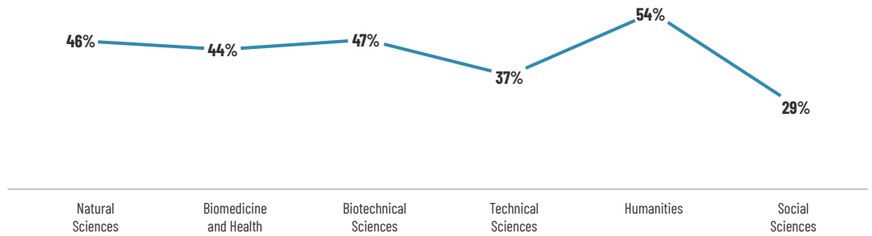


Figure 7b. First-year budgets of contracted projects per research institution, Call IP-2022-10

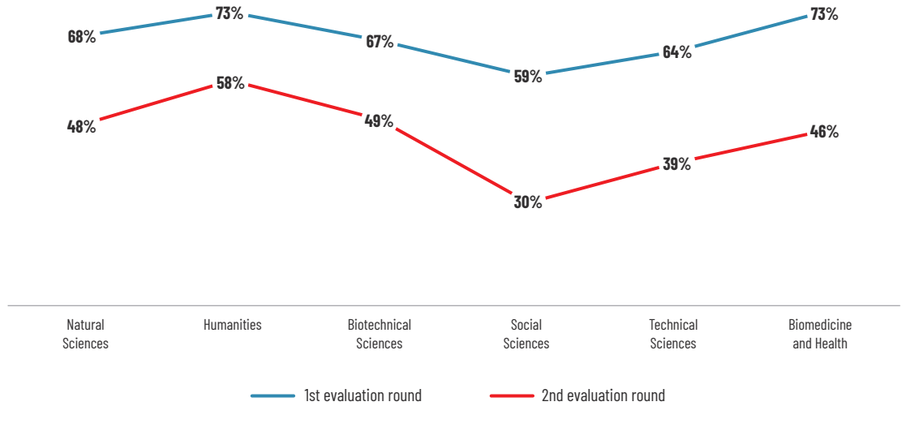
If we observe the success rate in individual research areas, the highest success rate has been recorded in the Humanities (54%), Biotechnical Sciences (47%), Natural Sciences (46%) and Biomedicine and Health (44%), while Technical and Social Sciences recorded the lowest success rates (37% and 29% respectively).

Figure 8. IP-2022-10 success rate per scientific area



The overall success rate in the first evaluation round was 64%, while in the second round it dropped to 46%. The success rates in the first and second evaluation rounds per scientific area are presented in Figure 9.

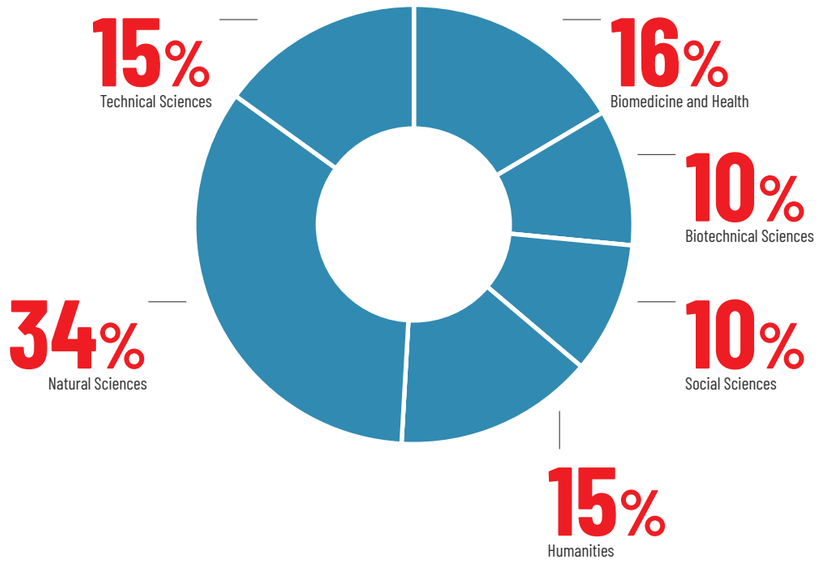
Figure 9. Success rates in the first and second evaluation rounds per scientific area, Call IP-2022-10



Monitoring ongoing research projects

In 2023, HRZZ monitored the implementation of 405 research projects and disbursed EUR 7,981,278.29 to these projects on the basis of periodic project reports evaluated by 415 fellow scientists. More than 9,870 scientists are engaged in activities of research projects, which includes PIs and team members, of which 96 are post-doctoral researchers (senior research assistants). The largest number of projects are funded in the Natural Sciences (34.1%) and Biomedicine and Health Sciences (16.5%), while the institutions implementing the largest number of projects are Ruđer Bošković Institute (53 projects) and three faculties of the University of Zagreb – Faculty of Science (25 projects), Faculty of Electrical Engineering and Computing (14) and School of Medicine (13) .

Figure 10. Percentage of Research Projects implemented throughout 2023 per scientific area



Data from the Croatian Scientific Bibliography (CROSBI) show that the Research Projects achieved the following results in 2023: 13 authored books and 9 edited volumes, 52 book chapters, 649 conference abstracts, 56 conference proceedings, 161 doctoral/master/graduation theses, 878 papers in academic journals.

Research Projects – IP-CORONA thematic call

The thematic Call IP-CORONA was designed for financing fundamental and applied scientific research that creates new and improves existing knowledge on the COVID-19 pandemic and on the enhancement of resilience of society against crisis situations, with an emphasis on health preservation, sustainable economic recovery and the development of high-quality and inclusive educational system in the Republic of Croatia.

Four projects financed through this Programme were in their implementation stage in 2023, but no funds were disbursed for their implementation.

Of the 15 projects financed through this programme, four projects finished their implementation in 2023 (all four from the Call IP-CORONA-2020-12).

The end of implementation of these four projects also marks the closure of the thematic call IP-CORONA. The primary objective of this thematic cycle was to improve knowledge on infectious diseases caused by corona viruses as well as to develop research dealing with social aspects of the pandemic and the effect of the pandemic on the education system.

Installation Research Projects

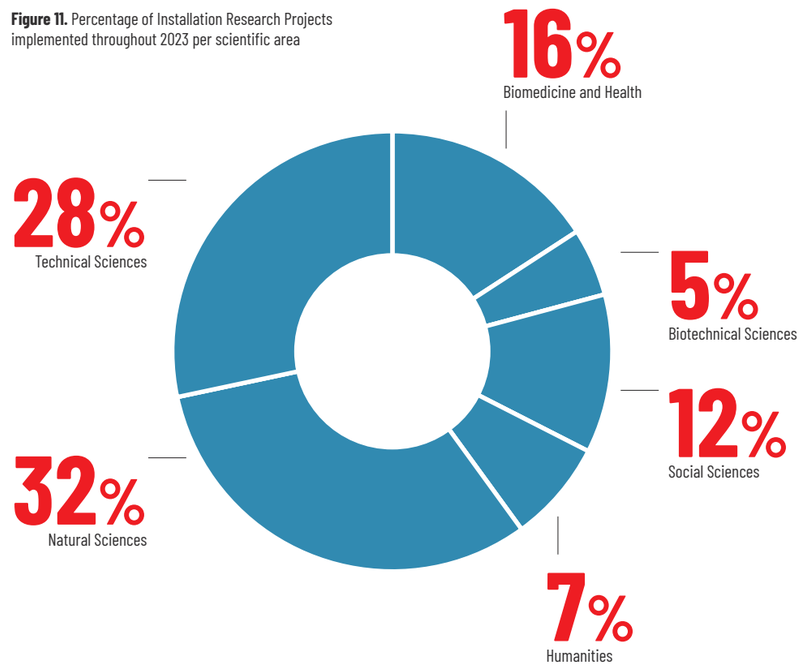
Funds disbursed for Programme in 2023
EUR
4,708,762.13

The goal of the Programme "Installation Research Projects" (UIP) is providing support to the establishment of new research groups of young scientists in order to accelerate the establishment of their autonomous research careers after the acquisition of a doctoral degree. Scientists who are evaluated positively will have the opportunity to establish their own research groups that will engage in innovative research topics.

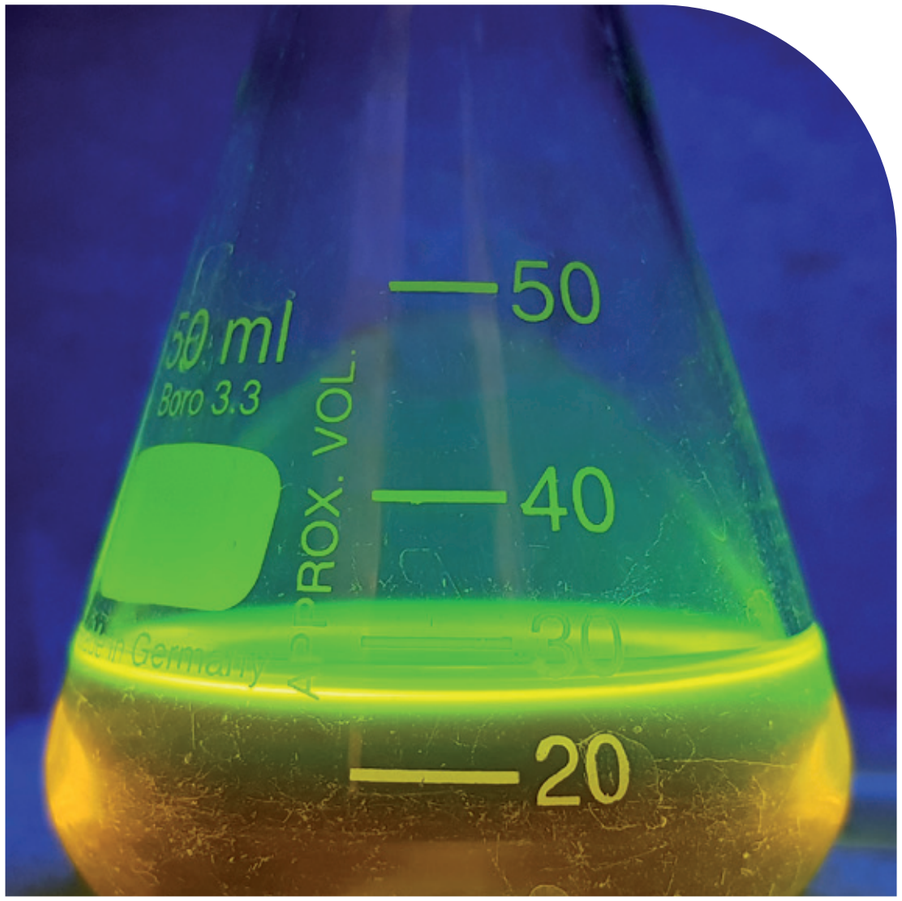
Young scientists should use the funding provided by HRZZ in a five-year period to set up their research teams and laboratories by recruiting research assistants and senior research assistants as well as covering research costs and acquiring scientific equipment. The research topic of these projects needs to be internationally recognisable and/or nationally relevant, while the applicant should have an excellent scientific track record. The maximum duration of installation research projects is 60 months, and the maximum amount of funding is EUR 265,445 (or EUR 199,084 for projects in the Social Sciences and Humanities).

In 2023, HRZZ monitored the implementation of 132 research projects and disbursed **EUR 4,708,762.13** to these projects on the basis of periodic project reports evaluated by 281 fellow scientists. More than 1,100 scientists are engaged in activities of installation research projects (Principal Investigators and team members), including 106 doctoral students/research assistants and 37 post-doctoral researchers/senior research assistants employed. The largest number of projects are funded in the Natural (31.7%) and Technical Sciences (28.3%), while the institutions implementing the largest number of projects are the University of Zagreb Faculty of Science (11), Ruđer Bošković Institute (8) and the Faculty of Civil Engineering and School of Medicine of the University of Zagreb (7 projects each).

Figure 11. Percentage of Installation Research Projects implemented throughout 2023 per scientific area



Data from the Croatian Scientific Bibliography (CROSBI) show that the Installation Research Projects achieved the following results in 2023: **2 books and 18 book chapters, 309 conference abstracts, 25 conference proceedings, 53 doctoral/master/graduation theses, 344 papers in academic journals.**



INTERNATIONAL PROGRAMMES

HRZZ implemented two calls in 2023 through the WEAVE initiative in the capacity of Partner Agency – one with the Swiss National Science Foundation (SNSF) and one with the Slovenian Research and Innovation Agency (ARIS). In addition, as stated above, HRZZ assumed the role of Lead Agency in the Call IP-2022-10.

Two international programmes were successfully complete in 2023 – the Croatian-Swiss Research Programme 2014-2023 (CSRP) and Cooperation Programme with Croatian Scientists in Diaspora "Research Cooperability". As part of the Second Swiss Contribution to selected EU-13 countries, in cooperation with the Swiss National Science Foundation (SNSF) we started developing a new funding mechanism called Multilateral Academic Projects (MAPS).

WEAVE

Weave is an instrument whose intention is to simplify the application and selection procedure for joint project proposals which are submitted jointly by researchers from not more than three European countries or regions by conducting a single evaluation procedure. WEAVE project proposals are submitted to existing national or regional funding programmes, while the evaluation is based on the Lead Agency procedure. At the Croatian Science Foundation, Weave is integrated into the Research Projects programme. WEAVE enables researchers from two or more countries to submit a joint research project proposal to the Lead Agency. This agency conducts the evaluation procedure according to its internal procedures. The funding recommendation is then forwarded to the other organizations (partner agencies) for their approval, without additional evaluation, pursuant to the Agreement on mutual recognition of evaluation procedures. This instrument is a sequel to the bilateral cooperation programme launched between HRZZ and the Slovenian Research and Innovation Agency (ARIS) in 2019 and the Swiss National Science Foundation (SNSF) in 2020. By 2025, we expect to expand our collaboration to other national European research funding organizations which are part of the Weave initiative.

In 2023, HRZZ started negotiations with the Czech Funding Agency (GAČR) and the German DFG. Collaboration with GAČR will start in early 2024 and the next available GAČR Call will also be open for bilateral Czech-Croatian proposals.

Research Projects – Slovenian-Croatian Bilateral Projects

Funds disbursed for Programme in 2023
EUR
530,239.27

Pursuant to the Bilateral Collaboration Agreement between the Slovenian Research and Innovation Agency (ARIS) and the Croatian Science Foundation, in February 2023 the Foundation published the Call for Slovenian-Croatian joint research projects (IPS-2023-02), with ARIS acting as the Lead Agency. By the submission deadline in March 2023, a total of 37 bilateral project proposals were submitted, with 34 being forwarded to the evaluation procedure following the eligibility check. The selection process was finished by late September, with four projects accepted for funding and contracted. Their implementation started in late 2023. A total of EUR 188,853.35 was disbursed in 2023 as the first instalment for their implementation.

In addition, eight projects funded through the Call IPS-2020-01 were also ongoing in 2023, with EUR 93,238.02 disbursed for their activities as well as eight projects from the Call IPS-2022-02, which received a total of EUR 248,102.90.

Research Projects – Swiss-Croatian Bilateral Projects

Funds disbursed for Programme in 2023
EUR
185,960.15

One call for co-financing the Croatian part of Swiss-Croatian joint research projects was launched in 2023 (IPCH-2023-10), with the submission deadline of 02 October 2023. The Lead Agency in this Call was SNSF. A total of nine bilateral project proposals was submitted to the IPCH-2023-10 Call, one of which failed to meet the formal and administrative criteria, resulting in eight proposals being forwarded to SNSF's evaluation procedure, which is ongoing. Call results are expected to be made public in the first half of 2024.

A total of four projects funded through previous IPCH calls were ongoing in 2023 - two projects from the Call IPCH-2020-10 with EUR 83,199.67 disbursed for their activities, one project from IPCH-2022-04, which received EUR 53,260.48 and one project from IPCH-2022-10, which received EUR 49,500.

Swiss-Croatian Cooperation Programme

The Second Swiss Contribution to selected European Union countries to reduce economic and social disparities within the EU includes, among others, a programme in the area of research and innovation, in which HRZZ will take part. In order to respond to the need for better integration within the European Research Area, the Swiss National Science Foundation (SNSF) developed a new funding mechanism called **Multilateral Academic Projects (MAPS)**, to be implemented within the Second Swiss Contribution. This instrument provides for a call for multilateral research project proposals with several partner countries (Bulgaria, Hungary, Poland and Romania), whose implementation should start in late 2024.

Croatian-Swiss Research Programme 2017– 2023 (CSRP)

The Croatian-Swiss Research Programme is implemented by HRZZ in collaboration with the Swiss National Science Foundation (SNSF). The Programme, which officially ended on 31 December 2023, funded 11 joint research projects implemented by Croatian and Swiss scientists in collaboration. All 11 projects finished their activities in 2023. Since all projects were granted cost-neutral extensions until 2023, there were no payments in 2023.

A total of 17 young researchers and 4 expert associates were recruited to work on these projects. The largest number of projects was funded in the Natural Sciences (54.55%) and Biomedicine and Health Sciences (27.2%), while the institution implementing the largest number of projects was the University of Zagreb Faculty of Science, which hosted 5 projects.

CSRP research teams published 8 research papers in 2023 and held 11 conference presentations. Outputs throughout the programme implementation period include more than 90 scientific papers published, 69 academic events held, established collaborations with 12 other countries, while three doctoral theses were successfully completed from the Croatian side.

The CSRP Programme was officially closed during the final conference, which took place on 19 October 2023 at the Zagreb Innovation Centre. The conference was attended by around 80 participants - apart from CSRP team members (Croatian and Swiss PIs and young researchers), who presented their projects and results, the list of attendees also included heads of several research institutions, fellow scientists, representatives of state bodies and agencies and entrepreneurs.

Promoting Excellence in Higher Education (TTP)

Funds disbursed for Programme in 2023
EUR
350,942.59

The Tenure Track Pilot Programme represents joint cooperation of the Croatian Science Foundation, Ministry of Science and Education and École polytechnique fédérale de Lausanne (EPFL), for the preparation of the tenure track model for the development of careers of excellent young researchers in Croatia. The goal of the programme is to support the establishment of the career of excellent young researchers in setting up an independent research group and acquiring conditions and skills for future employment. Such a Programme for excellent young scientists is a new model of career development based on clear and internationally competitive and comparable merit-based criteria.

Three research groups are funded through this Programme for a five-year period. Two projects are implemented at the Ruđer Bošković Institute, one is implemented at the University of Zagreb Faculty of Science. Each project has a budget of around EUR 1.5 million. Apart from the three PIs, additional 11 young researchers are receiving their salaries from the Programme (five doctoral students and six post-doctoral researchers). The implementation of projects will finish in mid-2024.

Cooperation Programme with Croatian Scientists in Diaspora "Research Cooperability"

Funds disbursed for Programme in 2023
EUR
1,556,465.34

The Research Cooperability Programme is financed from the European Social Fund as part of Specific Objective 10.ii.3. Improving the environment for Croatian researchers within the Operational Programme Efficient Human Resources 2014-2020 and co-funded from the State Budget of the Republic of Croatia.

The aim of the Programme is transfer of knowledge and attracting investments into the Croatian science and technology system, and indirectly into the economy as well, through collaboration between Croatian-based scientists and scientists of Croatian origin who live and work abroad. Such collaboration would enhance the collaboration and networking potential of Croatian scientists in Croatia and the diaspora, with special emphasis on career development of early-career researchers. In addition, it is intended to develop and strengthen their capacities for participation in international calls.

Scientific projects funded through this Programme were to be implemented by 31 May 2023 at the latest, with the obligation to recruit two full-time young researchers per project. Funding per project was provided in the minimum amount of EUR 132,722.81 and EUR 291,990.18 maximum.

A total of 22 projects were funded through the Research Cooperability Programme, which received a total of EUR 1,556,465.34 in funding in 2023. 34 doctoral students and 18 post-doctoral researchers have been recruited to work on these projects.

The highest number of projects were funded at the University of Zagreb (12) and Ruđer Bošković Institute (5). The largest number of projects were classified as Biomedicine and Health (17.39%), followed by Biotechnical Sciences and Social Sciences (8.69% each).

The Programme officially ended in 2023. Programme outputs include more than 220 research papers published in Q1 and Q2 journals, with PhD students being listed as first or second author on 183 papers. The Programme also resulted in 2 innovations and 2 patent applications. Principal Investigators received numerous awards, one of which was the National Award for Science. Four young researchers that had been employed through this programme remained at the host institutions after the end of the projects, while the Foundation continued financing 28 doctoral students from other sources. The overall outcomes also include three book chapters and one book, two doctoral dissertations defended, while project members presented their work at more than 120 national and international conferences.

The final conference of the Programme, which took place on 10 October 2023 at the Croatian Heritage Foundation, was used to present the results of the projects and to reward the most successful projects - five projects that received the maximum marks from HRZZ's evaluators and Steering Committee throughout the implementation period.

ERA-NET programmes

Funds disbursed for Programme in 2023
EUR
90,584.47

The European Union supports the coordination of national research programmes at the European level through ERA-NET programmes with participation of national research funding organizations (RFO). The consortium of national RFOs taking part in an ERA-NET launches calls for transnational research projects which enable researchers from various countries to implement joint research projects. The European Commission co-funds these projects in the amount of up to 33% through the instrument recently renamed as ERA-NET COFUND.

The Croatian Science Foundation takes part in three ERA-NET consortia: BlueBio (ERA-NET Cofund on Blue Bioeconomy – Unlocking the potential of aquatic bioresources), Quantera (ERA-NET Cofund in Quantum Technologies) and Chanse (Collaboration of Humanities and Social Sciences in Europe).

The BlueBio Network (ERA-NET Cofund in Blue Bioeconomy) gathers 28 partners from 17 European countries (Belgium, Denmark, Estonia, Finland, Croatia, Germany, Greece, Ireland, Iceland, Italy, Malta, Norway, Portugal, Romania, Spain and Sweden), whose objective is to secure sustainable and competitive blue economy in Europe, to develop knowledge on value chains in blue bioeconomy, to encourage the application of research results, innovations and demonstrations of bioproducts in production through a multi-shareholder approach. The BlueBio Project shall contribute to the production of safe, nutritious and quality bioproducts and services. HRZZ finances **two research teams** within the BlueBio network, for which EUR 27,770.25 was disbursed in 2023.

The QuantERA network (ERA-NET Cofund in Quantum Technologies) was launched in 2016 and is currently the leading European network of public RFOs in the field of quantum technologies. The network gathers 38 organizations from 31 countries. The network secured over EUR 40 million of national contributions and additional EUR 15 million of European Commission co-financing for its new programme, QuantERA II. QuantERA II launched a transnational call in 2021, with 39 new projects selected for financing in the fields of quantum phenomena and resources and applied quantum science. This number includes one project with Croatian participation – NImSoQ – New Imaging and control Solutions for Quantum processors and metrology. The Croatian team is led by **Dr Neven Šantić** from the Institute of Physics. The project received EUR 62,814.22 of funds in 2023.

The Call QuantERA II, which was implemented in 2023, saw a total of 101 project proposals submitted - 56 in the topic Quantum Phenomena and Resources (QPR) and 45 in the topic Applied Quantum Science (AQS). Five of these proposals included Croatian partners - 4 in QPR and 1 in ACS. Following the international evaluation procedure, 24 projects were selected for funding, including one project with a Croatian partner - QNet: Transport, metastability and neuromorphic applications in quantum networks was submitted in the topic Applied Quantum Science, and the Croatian PI is **Dr Ticijana Ban** from the Institute of Physics. The implementation of this project will start in 2024.

The HERA-NORFACE ERA-NET CO-FUND (Humanities in the European Research Area and New Opportunities for Research Funding Agency Cooperation in Europe consortium comprises 27 organizations for funding research in the Social Sciences and Humanities from 24 European countries. When applying for additional European Commission funding through Horizon 2020, this ERA-NET programme has been renamed to CHANSE. The consortium secured over EUR 26 million of national contributions and additional EUR 10 million of European Commission co-financing. March 2021 saw the launch of the transnational Call **Transformations: Social and Cultural Dynamics in the Digital Age**. The Call results were revealed in May 2022, and the list of contracted projects includes two projects with Croatian participation: Researching Europe, Digitalisation, and Conspiracy Theories (Croatian team leader: **Prof. Nebojša Blanuša, PhD**, Faculty of Political Sciences, University of Zagreb) and Digital Aestheticization of Fragile Environments (Croatian team leader: **Dr Sanja Đurin**, Institute for Ethnology and Folklore Research).

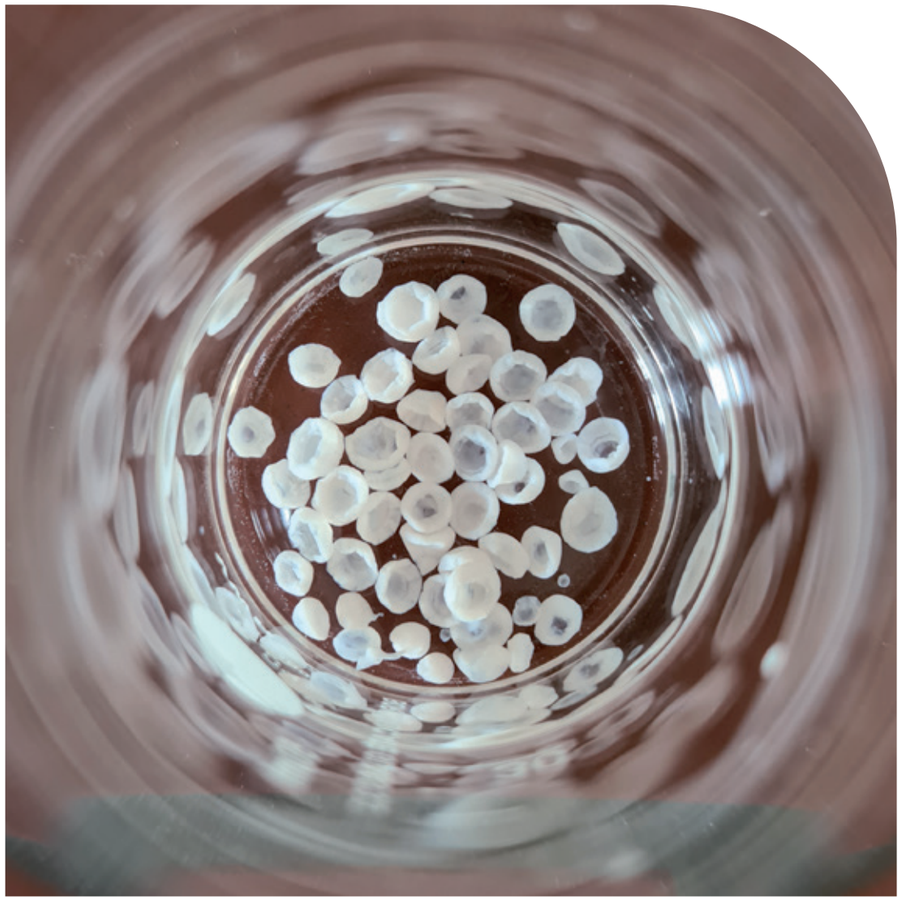
CHANSE consortium published two transnational calls in 2023: Crisis-Perspectives from the Humanities (for project proposals in the Humanities) and Enhancing well-being for the future (for project proposals in the Social Sciences). HRZZ's Department for International Cooperation handled the eligibility check of Croatian partners and nominated Evaluation Panel members. The former call saw 195 submissions, with 24 proposals including Croatian partners, while 144 project proposals were submitted to the latter call, with 15 proposals including research teams from Croatia. Call results are expected to be made public in the first half of 2024, after which selected projects will start their implementation.

Trans-Atlantic Platform for Social Sciences and Humanities (T-AP)

The Trans-Atlantic Platform for Social Sciences and Humanities (T-AP) is a network of research funding organizations from Europe and the Americas. The aim of this platform is to raise public awareness on the relevance of social sciences and humanities in the 21st century. Within the thematic Call "Recovery, Renewal and Resilience in a Post-Pandemic World", implemented in 2021, one project with Croatian participation was selected for funding . Implementation of the project started in June 2022 for a three-year period. The project Inequalities, Community Resilience and New Governance Modalities in a Post-Pandemic World (ENDURE) is coordinated by Dr. Mihai Varga from Freie Universität in Berlin, while the Croatian team is led by Dr Senada Šelo Šabić, PhD from the Institute for Development and International Relations. The project received EUR 30,057.07 of funds in 2023.

Funds disbursed for Programme in 2023
EUR
30,057.07

A new T-AP Call "Democracy, Governance and Trust" was published in 2023, with the submission deadline of 6 November 2023. The Call was open for transnational consortia composed of at least three partners from three different participating countries and had to include partners from both sides of the Atlantic. A total of 121 proposals was submitted to the Call, five of which included Croatian partners. Call results are expected to be made public in mid-2024.



YOUNG RESEARCHERS' CAREER DEVELOPMENT PROJECT – TRAINING NEW DOCTORAL STUDENTS

One of HRZZ's strategic goals is funding career development of young researchers. The Programme objective is to fund between 200 and 250 new doctoral students every year, depending on the available funds from the State Budget, in order to reach the critical mass of 1,000 doctoral students constantly in HRZZ's grant system.

The programme provides stable funding for young researchers' career development and enables mentors include research-oriented doctoral students into their projects, thus directing their careers toward top-notch science. The ultimate goal of these calls is to educate new PhDs, who would pursue a career in competitive research or industry. Funding includes doctoral students' annual gross salary, including commute costs and other social expenditures for employees. Calls within this programme are open for prospective mentors – scientists permanently employed at Croatian scientific institutions who are Principal Investigators or team members of scientific projects funded by HRZZ, EU and other international competitive sources. Funding for one generation of young researchers expired in 2023 – those co-funded through the European Social Fund (ESF) as part of Operational Programme 10.II.3. Improving Conditions for Croatian Researchers.

On 31 December 2023, the Young Researchers' Career Development Project counted 510 doctoral students whose funding was ongoing. In 2023, a total of EUR 12,190,699 was disbursed from the State Budget of the Republic of Croatia for covering salaries of doctoral students. Apart from the Young Researcher's Career Development Project, we also used the State Budget funds to finance research assistants that were previously funded through our other programmes (7 from CSRP, 28 from PZS and 13 through ESF). HRZZ has taken over the funding of these doctoral students after the projects they were recruited to were completed, so that they could continue their doctoral research for the standard period of 48 months.

The monitoring procedure entails the evaluation of doctoral students' progress reports. In accordance with the terms and conditions of the Call and their contractual obligations, mentors and doctoral students are obliged to submit periodic reports on the doctoral student's progress after 18 and 36 months respectively. Doctoral student's progress reports are an essential source of information to HRZZ regarding the doctoral student's progress, their achievements in both their doctoral studies and their research within the mentor's project. The monitoring procedure included 55 evaluators, who evaluated 347 reports in 2023.

118 young researchers funded by the Croatian Science Foundation obtained their doctoral degree in 2023.

Funds disbursed for Programme in 2023
EUR
12,190,699

Doctoral students in numbers (2023)

10
new doctoral students recruited

118
doctoral theses defended

more than **620**
doctoral students monitored, in various stages of their doctoral studies

over **500**
conferences attended

more than **400**
published journal papers

more than **150**
publications with doctoral students listed as the first or only author

over **60**
thesis topics defended

1
state prize for science in the category of young researchers

NATIONAL RECOVERY AND RESILIENCE PLAN (NPOO)

Mobility Programme

The Croatian Science Foundation is the Beneficiary of funds from the National Recovery and Resilience Plan (NPOO) for the implementation of the Mobility Programme as part of Investment C3.2.R2-I1 "Developing a stimulating career advancement model and conducting leading scientific research in STEM and ICT". In 2023, HRZZ implemented the Mobility programme through three sub-components: Outbound mobility of research assistants, Outbound mobility of senior research assistants and Inbound mobility of senior research assistants.

Outbound mobility of research assistants (MOBDOK-2023)

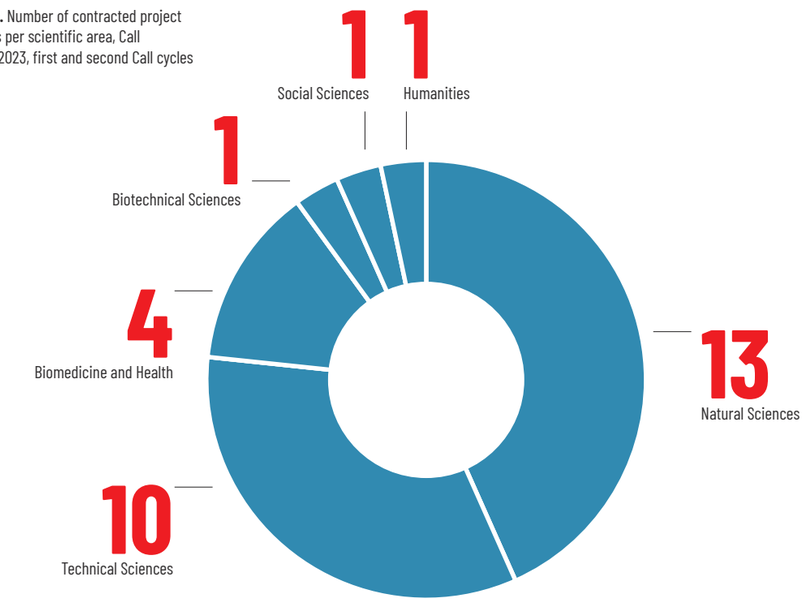
The objective of the sub-component "Outbound mobility of research assistants" is to provide junior research assistants with an opportunity to visit top research institutions abroad in order to establish collaboration and acquire new skills they need to work on their doctoral dissertations. The Call was launched in April 2023 as a permanently open call divided into three-month cycles (the Call will close on the day all funds earmarked for the sub-component have been exhausted). The total budget for this sub-component is EUR 1,798,600 and will be disbursed in the form of scholarships for short-term scientific training at an organization abroad. Eligible countries in which scientific training can be performed are EU Member States, Horizon Europe Associated Countries and Switzerland. Applicants to this Call are public research organizations as defined in the Act on Higher Education and Scientific Activity (OG 119/22), whereas End Beneficiaries are researchers employed as research assistants at an eligible applicant organization throughout the mobility period.

The first Call cycle (cycle closure date: 20 June 2023) saw 14 applications submitted from all scientific areas, the most from Biomedicine and Health (50%) and Technical Sciences (21%) (Figure 12). Three applications were rejected during the eligibility check. All eligible applications submitted to the first Call cycle were evaluated positively and awarded funding. After one End Beneficiary withdrew their application, **ten projects were eventually contracted**. Total amount of contracted scholarships in the first Call cycle is EUR 102,935.

In addition, the second Call cycle closed on 20 September 2023, with 22 applications submitted and total requested funds of EUR 150,280.00. The distribution of proposals to this Call cycle based on the scientific areas declared by the applicants is as follows: the largest number of proposals was submitted in Natural Sciences (45%) and Technical Sciences (32%). Of the 22 submitted project proposals, two were declared ineligible, while the remaining 20 were evaluated positively and accepted for funding (contracting will take place in January 2024). Total amount of contracted scholarships in the second Call cycle is EUR 144,670.

Figures 12, 13 and 14 provide an overview of approved mobility projects by scientific area, applicant organizations and countries in which the mobility project will be implemented, cumulatively for the first two Call cycles.

Figure 12. Number of contracted project proposals per scientific area, Call MOBDOK-2023, first and second Call cycles



One half of all end beneficiaries of this sub-programme are employed at the University of Zagreb, while the second-largest beneficiary institution is Ruđer Bošković Institute.

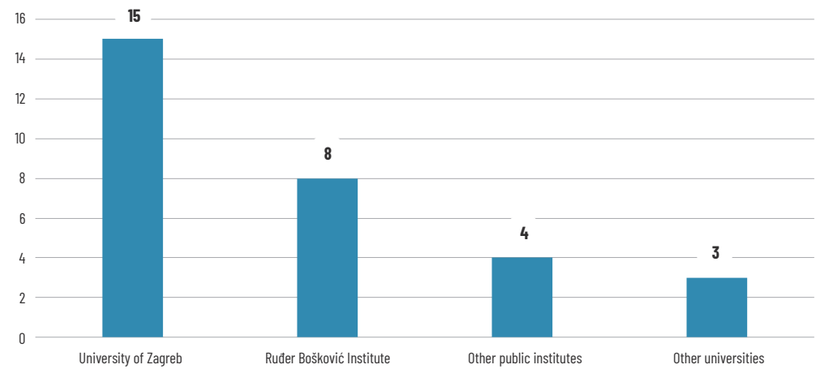


Figure 13. Number of accepted projects per public research organization, Call MOBDOK-2023, first and second Call cycles

With regard to the planned destination of the mobility project, the greatest number of scientific trainings will be completed in the United Kingdom and Spain, followed by Slovenia, Switzerland and France.

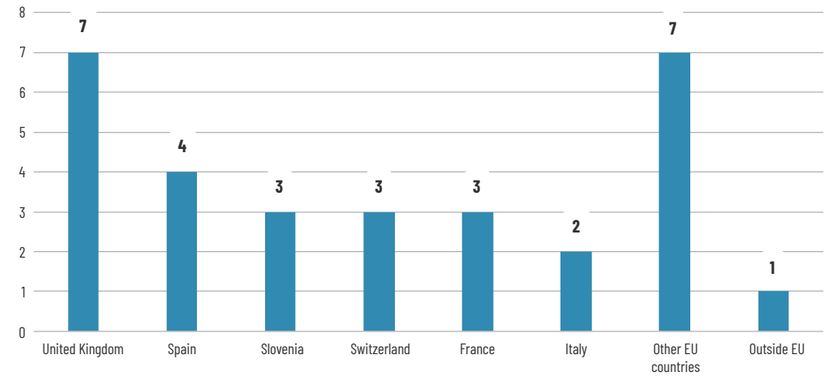


Figure 14. Number of contracted projects per country of short-term scientific training, Call MOBDOK-2023, first and second Call cycles

The third Call cycle, which closed on 20 December 2023, saw 26 project proposals submitted. All applications will be forwarded to the formal eligibility check and evaluation in Q1 2024, while the funding decision will be adopted by March 2024. 2024 cycles are scheduled to close on 20 March, 20 June, 20 September and 20 December.

Outbound mobility of senior research assistants (MOBODL-2023)

The objective of the sub-component "Outbound mobility of senior research assistants" is to enable talented young researchers to spend some time abroad to acquire and transfer new knowledge and methodologies, develop new skills and international experience required for a successful academic or business career. The total budget of this sub-component is EUR 2,400,000, which will be awarded in the form of scholarships for long-term stays of young researchers at a post-doctoral level at top research institutions abroad (EU Member States, Horizon Europe Associated Countries and Switzerland). **The duration of these research stays is between 12 and 24 months.** Applicants to this Call are public research organizations as defined in the Act on Higher Education and Scientific Activity (OG 119/22), whereas End Beneficiaries are young researchers who obtained their doctoral degree not more than 7 years before the application deadline and are employed at an eligible applicant organization at any research position throughout the mobility period.

The sub-component is implemented through two separate calls, with application deadlines in August and December 2023 respectively. The first Call (MOBODL-2023-08) saw 32 applications submitted with a total requested budget of EUR 1,916,000. The distribution of proposals to this Call based on the scientific areas declared by the Applicants was as follows: the largest number of proposals was submitted in Natural Sciences (41%), followed by Biomedicine and Health Sciences (28%) and Technical Sciences (13%). All other scientific areas (Humanities, Biotechnical Sciences and Social Sciences) received 6% of proposals each.

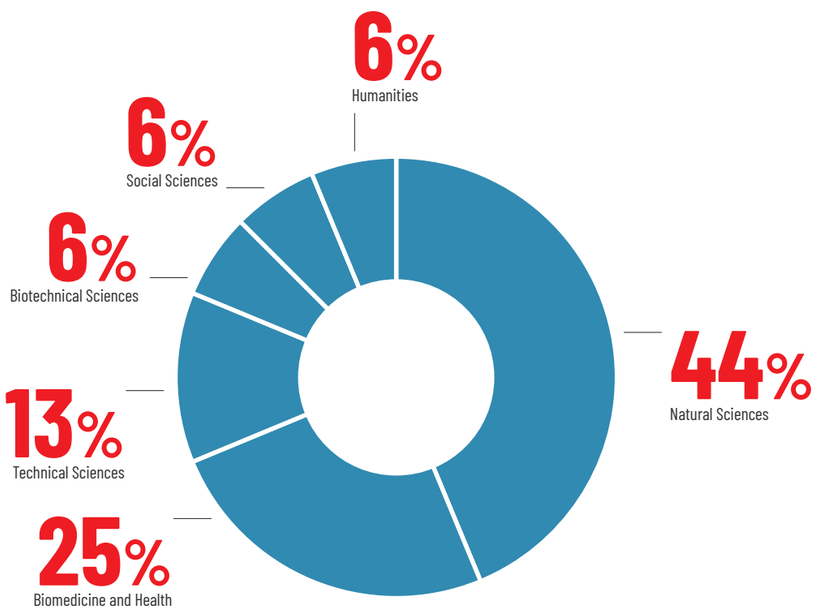


Figure 15. Percentage of submitted project proposals per scientific area, Call MOBODL-2023-08

In addition, the majority of project proposals were submitted from the University of Zagreb (53%) and Ruđer Bošković Institute (34%), followed by University of Rijeka (9%) and other research organizations in Croatia (3%) (Figure 18). All submitted project proposals met the eligibility conditions and were evaluated positively. The funding decision and contracting of these projects are expected in early 2024.

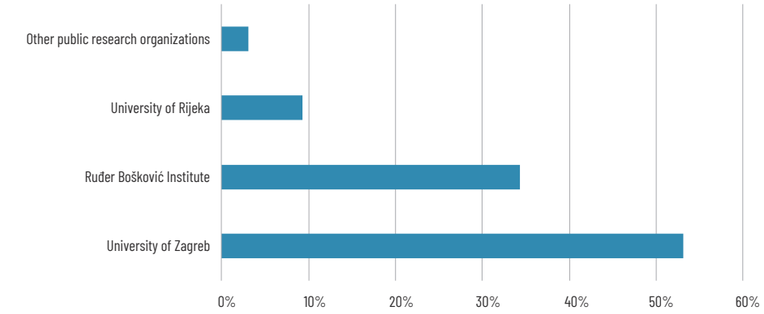


Figure 16. Percentage of submitted project proposals per research organization, Call MOBODL-2023-08

The majority of mobility projects will be implemented at research organizations based in Spain and Slovenia (6 each), as shown in Figure 17.

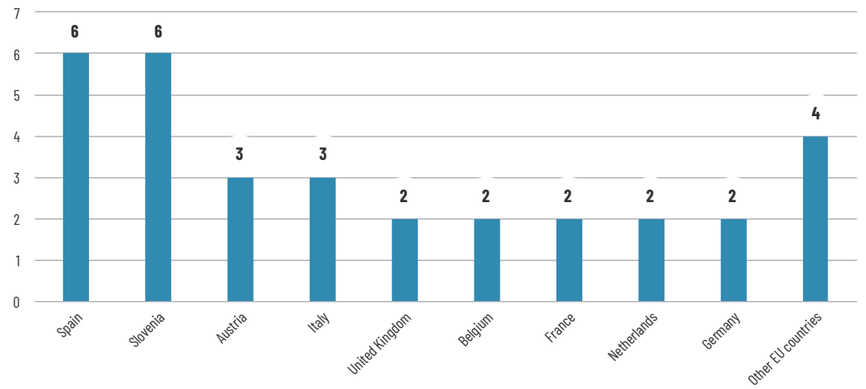


Figure 17. Number of approved mobility projects per destination country, Call MOBODL-2023-08

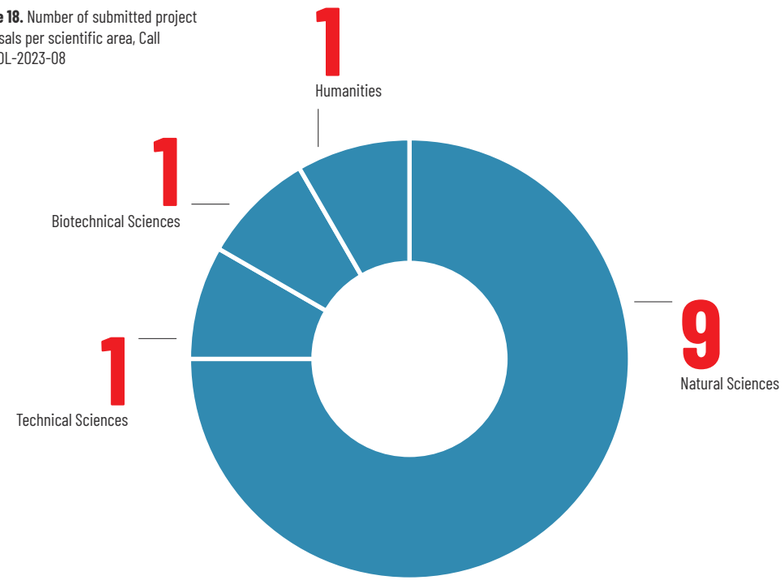
The second Call, launched in September 2023 with 1 December 2023 as the submission deadline (MOBODL-2023-12), saw 43 project proposals submitted, which will be forwarded to evaluation in early 2024.

Inbound mobility of senior research assistants (MOBDOL-2023)

The objective of the sub-component "Inbound mobility of senior research assistants" is to increase the competitiveness and internationalization of the Croatian research and development (R&D) system by attracting talented young researchers and integrating them in the Croatian R&D system. Calls published through this sub-component will award scholarships for scientific training of young researchers from abroad at Croatian organizations for a period of between 12 and 24 months. Applicants to this Call are public research organizations as defined in the Act on Higher Education and Scientific Activity (OG 119/22), whereas End Beneficiaries are researchers from abroad who obtained their doctoral degree not more than 7 years before the application deadline (Visiting Researchers) and who will be spending their research visit at the Host Organization.

The sub-component, with the total budget of EUR 1,827,000, will be implemented through two separate calls, with application deadlines in August and December 2023 respectively. The first Call (MOBDOL-2023-08) saw 12 applications submitted with a total requested budget of EUR 888,125.00. One project proposal failed to meet the formal eligibility criteria, while the remaining 11 proposals were evaluated positively. The funding decision and contracting is set to take place in early 2024. Structure of submitted project proposals per scientific area and public research organization is provided in Figures 18 and 19.

Figure 18. Number of submitted project proposals per scientific area, Call MOBDOL-2023-08



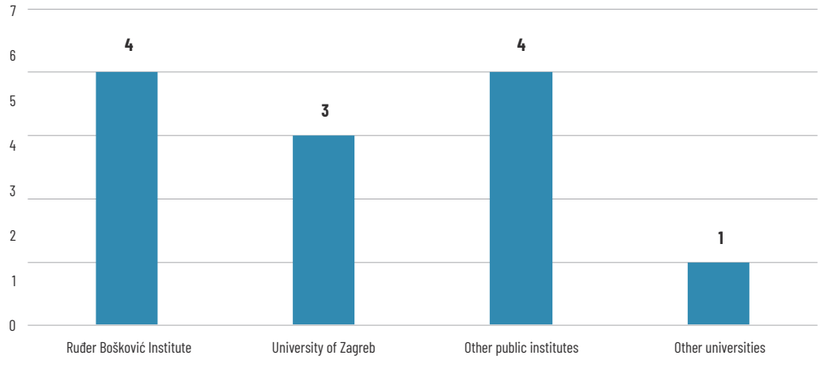


Figure 19. Number of submitted project proposals per research organization, Call MOBDOL-2023-08

The second Call (MOBDOL-2023-12), launched in September 2023 with 1 December 2023 as the submission deadline, saw 16 project proposals submitted, which will be forwarded to evaluation in early 2024.

Young Researchers' Career Development – Training New Doctoral Students (NPOO-DOK-2023-10)

The Croatian Science Foundation is the Beneficiary of funds from the National Recovery and Resilience Plan (NPOO) for the implementation of the Programme "Young Researchers' Career Development - Training New Doctoral Students" as part of Investment C3.2.R2-I1 "Developing a stimulating career advancement model and conducting leading scientific research in STEM and ICT".

The Call was launched on 20 July 2023, enabling Croatian research organizations and scientifically active mentors dealing with internationally and/or nationally relevant topics to include young researchers (doctoral students) into their projects, thus directing their careers toward top-level science. The ultimate objective of the Programme is to educate new PhDs, who would pursue a career in competitive research or developing new technologies in the economic sector. The Call also aims to strengthen mentoring capacities in Croatian scientific institutions, the transfer and application of new knowledge and enhance the quality of postgraduate education and scientific development of young researchers.

The Development Research Support Programme shall support projects of the best young researchers - senior assistants or assistant professors who obtained their doctoral degree not less than 2 and not more than 7 years ago, providing between EUR 400,000 and 750,000 of funding.

For the purpose of this Call, the Applicant is a public research organization that declares an interest in recruiting junior research assistants and nominates candidates for mentors of these research assistants. The mentor should be an active researcher and is responsible for scientific progress of the candidate. In its application, the Organization was to declare the number of required research assistants. This number should be justified through the Organization's previous results, current capacities and needs, planned activities (the doctoral student's education plan, work methods and tasks) and its potential for professional development.

The submission deadline for applicant organizations was 24 October 2023, while proposed mentor candidates were due to deliver additional documentation by 7 November 2023. A total of 371 applications (from mentor candidates) were submitted by the deadline, which will be forwarded to the evaluation procedure. The evaluation will be completed in the first half of 2024.

Development Research Support

In 2023, the Croatian Science Foundation assumed the role of Implementation Body (IB) for the Programme "Development Research Support", NPOO.C3.2.R2-I1.06, implemented as part of the National Recovery and Resilience Plan 2021-2026.

The Programme is implemented within the sub-component C3.2 "Increasing research and innovation capacities", Reform 2, Investment 1 Developing a stimulating career advancement model for researcher and conducting excellent scientific research in STEM and ICT. The Competent Body for this Call is the Ministry of Science and Education. Grants awarded through this Call are aimed at supporting the development of excellent young researchers by enabling them to lead their own research projects. Support will be provided to projects of excellent young researchers (senior research assistants or assistant professors) who obtained their doctoral degrees not less than 2 and not more than 7 years before the call deadline.

The Programme objective is increasing international attractiveness, recognition and visibility of the Croatian research system by implementing programmes that support the career development and advancement system in Croatian research organizations. Eligible applicants include research and knowledge dissemination organizations, as defined in the Framework for State aid for research and development and innovation (2022/C 414/01), Art. 1.3(16ff.). The total amount of grants that can be awarded through this Call was EUR 10,020,572.04. The minimum grant for an individual project is EUR 400,000.00, while the maximum is EUR 750,000.00.

The Call was launched in November 2022 with May 2024 set as the application deadline. A total of 177 project proposals were submitted, which have been forwarded to the evaluation procedure. Of the 177 submissions, 41 proposals failed to meet the formal eligibility criteria. 136 proposals were forwarded to the quality assessment stage, of which 25 failed to meet the minimum quality requirements as defined in the Call. The evaluation stage finished in September 2023, while the Funding Decision should be adopted in early 2024.

Targeted Scientific Research

The Targeted Scientific Research Programme shall support collaborative industrial research projects, to be jointly implemented by enterprises and research organizations.

In 2023, the Croatian Science Foundation assumed the role of Implementation Body (IB) for the Programme "Targeted Scientific Research", NPOO.C3.2.R3-I1.04, implemented as part of the National Recovery and Resilience Plan 2021-2026. The Call was published on 21 April 2023.

This Programmes supports collaborative projects in the field of industrial research that are implemented jointly by enterprises and research organizations. Research conducted through this Programme are expected to clear the path for research of higher technology readiness levels, experimental development and innovation activities. The Programme aims to encourage the creation of long-term relations and collaboration between consortium members that would resume long after the supported projects have finished.

The projects will be implemented by consortia made up of one applicant and one or more partners. The consortium needs to comprise at least one research organizations and at least one commercial entity. Both research organization and enterprise may assume the role of applicant or partner. The proposed collaboration should help research organizations to better define research paths with the business sector, which should add practical value to their research. On the other hand, the support should enable commercial entities to get more involved in excellent research, help them understand the academic community better and to benefit from excellent research in the long term.

The submission deadline was 31 October 2023. A total of 329 project proposals were submitted, which have been forwarded to the evaluation procedure.

RESEARCH STORIES

The project team (Jasminka Popović, Ivor Lončarić, Luca Grisanti and Juraj Ovčar) from the Ruđer Bošković Institute and colleagues from the Physics Department of the Faculty of Science at the University of Zagreb (Željko Skoko), Hong Kong University (Aleksandra Djurišić), Hong Kong University of Science and Technology (Kam Sing Wong) and City University of Hong Kong (Andrey Rogach) during the first 18 months of project implementation clearly demonstrated the exceptional importance of synergy between a large number of different experimental methods and advanced theoretical calculations for understanding and improving the optoelectronic performance of perovskite light-emitting diodes.

The results, which demonstrated that the performance of LEDs depends on the type but also the ratio of small organic cations within the perovskite layer, were published in the prestigious journal **Advanced Optical Materials (IF=9.93)**. The best LEDs were obtained when cesium (Cs) and formamidinium cation (FA) were used for small organic cations in a 1:1 ratio. Such diodes show a maximum efficiency of 12.1% and a maximum light intensity of 15070 cd/m2, which is 3 times higher compared to devices containing only FA cation or only Cs cation. The photoluminescence quantum yield is also significantly improved to 21.3% (compared to only 5% for samples with only FA or Cs). A similar finding was also found in the case when two different cations are used instead of one type of large organic (spacer) cation in perovskite, which was published in the **Journal of Materials Chemistry C (IF=7.39)** published by the prestigious British publisher Royal Society of Chemistry. The paper demonstrated that a light-emitting diode containing simultaneously both butylammonium and phenethylammonium cations shows a significantly higher ambient stability and significantly improved optoelectric properties compared to materials that are made of only one type of spacer cation.

Research on perovskite materials has been further extended from lead to tin perovskites. Lead-free 2D perovskites that crystallize in the type of Dion-Jacobson structures attract a lot of attention due to their significantly higher stability compared to Rudlesden-Popper structures, but often such lead-free perovskites do not emit in the visible region, which

PROJECT TITLE:
Exploring halide 2D and quasi-2D perovskites: from rational structural design to enhanced efficiency and stability

CALL: PZS-2019-02

PRINCIPAL INVESTIGATOR:
dr. sc. Jasminka Popović

CO-PRINCIPAL INVESTIGATOR: Prof. Aleksandra Djurišić, Department of Physics, Hong Kong University

HOST ORGANIZATION: Ruđer Bošković Institute

PROJECT DURATION:
01.10.2019 - 31.05.2023

SCIENTIFIC AREA: Natural sciences

prevents them from being applied in light-emitting diodes. Nevertheless, research published in **Advanced Functional Materials (IF= 18.80)** showed that ODASnBr4 with crystallized solvent molecules emit in the range of 570–608 nm (depending on the type of solvent) and show high photoluminescence quantum yields. Such exceptional optoelectronic properties are a consequence of strong hydrogen bonds between [SnBr6]4-octahedra and acidic proton donors from chloroform and dichloromethane molecules. The research results clearly demonstrate the importance of chemical engineering of perovskite materials and provide guidelines for future improvements in optoelectronic properties using targeted design focused on tailoring material properties using intermolecular interactions as the most important tool to achieve this goal.

Increased interest of the scientific community in hybrid perovskites actually lies in the fact that the hot charge carriers in them cool down slowly, which made it possible to produce solar cells with much higher efficiency and at the same time much cheaper to produce. The binding of electrons and phonons (vibrations) in these materials is responsible for this phenomenon, so it is extremely important to understand this binding, especially compared to traditional semiconductors. Using transient absorption spectroscopy under the guidance of Prof. Kam Sing Wong and theoretical calculations based on density functional theory led by Dr Ivor Lončarić determined the electron-phonon coupling in typical 3D lead halide perovskites. These results provide a new perspective for quantifying energy flow in hybrid halide perovskites and resolve existing experimental contradictions. The results were published in the extremely prestigious journal **Advanced Energy Materials (IF=29.37)** and featured on the back cover of that journal issue.

The project investigates the mechanisms of the development of suction in the tiny pores of soil/soft rock (and other geomaterials) and the related processes of "attrition" (wear, degradation over time) of these materials, which are present in the environment and lead to significant problems in the construction and maintenance of buildings. These processes are especially pronounced in the coastal area and accelerated due to climate change.

Attrition, as the degradation or decomposition of rock material under the direct influence of environmental conditions and human activity in the period of the engineering time scale, is a key process that controls geomorphological and ecological processes, and through them also affects social events. Soft rocks such as marl, which is very widespread in the Mediterranean area (e.g. Eocene flysch deposits), are especially susceptible to attrition. This influence is manifested in the breakdown of binders from the structure of clayey rocks and in the breaking of the material into smaller fragments due to the simultaneous processes of physical and chemical wear. Under the influence of weathering factors, soft rocks are degraded down to fine-grained material, which is associated with problems of environmental sustainability (accelerated erosion, effects of climate change, landslides, rockfalls and other geohazards) and stability, load-bearing capacity and durability (changes in strength and deformation properties over time). .

According to recent scientific knowledge, a significant contribution to the development of consumption is made by the process of differential suction and the resulting differential swelling in unsaturated conditions. Suction is a consequence of the capillary effect in the small pores of the material and is closely related to the process of cracking or tempering of the material. That is, the consequence of differential swelling is the development of tensile and shear stresses that lead to tempering and wear. Therefore, the goal of this project is to investigate and model the mechanisms of attrition from the aspect of suction, and to connect the knowledge obtained with numerous research on the topic of attrition factors collected through systematic work at the Faculty in the previous period.

Through experimental research with sophisticated research equipment, Soil Water Characteristic Curve (SWCC) is determined depending on stress or other influencing factors on yet untested soft rock materials from the coastal area of the Republic of Croatia (marls ranging from intact rock to residual flysch soil) as well as the strength/deformability properties of these materials in unsaturated conditions for a given suction condition. At the same time, accompanying physical-mechanical and mineralogical-petrographic tests are carried out with the aim of connecting the new and existing databases. The full test program is planned for 30 samples. In addition to testing with the pore pressure "translation" technique (axial translation), research is being expanded and improved through new international collaborations and testing methods. In addition to testing and calibration, the obtained results enable the use of the existing numerical model (Plaxis), and a new 2D numerical model based on a discrete approach is being developed that can include the fracture mechanism in geomaterials under unsaturated flow conditions.

PROJECT TITLE:
Experimental and numerical investigations of mechanisms in unsaturated geomaterials – UNSAT1

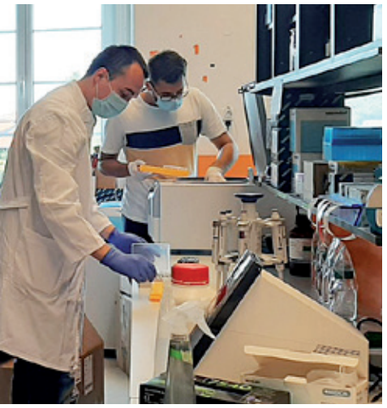
CALL: UIP-2017-05

PRINCIPAL INVESTIGATOR:
izv. prof. dr. sc. Nataša Štambuk Cvitanović

HOST ORGANIZATION:
University of Split, Faculty of Civil Engineering, Architecture and Geodesy

PROJECT DURATION:
01.03.2018 - 31.08.2023

SCIENTIFIC AREA: Technical Sciences



PROJECT TITLE: Epigenetic Biomarkers in Prostate Cancer – epiPro

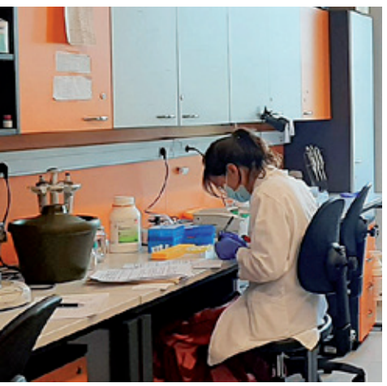
CALL: UIP-2017-05

PRINCIPAL INVESTIGATOR:
izv. prof. dr. sc. Nino Sinčić, dr. med.

HOST ORGANIZATION:
University of Zagreb School of Medicine

PROJECT DURATION:
01.04.2018 - 31.03.2023

SCIENTIFIC AREA:
Biomedicine and Health



Epigenetic research on human disease biomarkers is gaining momentum in the world's biomedical community, while in Croatia this field is just beginning to develop. Therefore, within the framework of this project, a group of established young scientists from the field of fundamental and clinical biomedical sciences was gathered to form the Epigenetic Biomarker Research Group (epiMark). The activity of the epiMark group is directed, in addition to scientific research, to raising awareness in the Croatian scientific community about the importance of epigenetics and epigenetic disorders in understanding human health and disease and the translational potential of epigenetic research into modern medical practice. Indeed, in a short two-year period, epiMark members became collaborators and consultants in a number of national and international scientific projects that recognized the value of including the epigenetic segment in order to improve their research.

In addition to other research projects, the focus of the epiMark group is research on epigenetic biomarkers of prostate cancer (epiPro). Namely, prostate cancer is the most frequently diagnosed malignant disease in men in the Republic of Croatia. Screening for prostate cancer is challenging since the leading biomarker PSA is not specific enough. Its value in the blood also increases in benign prostatic hyperplasia (BPH), a benign condition that affects most older men and coincides with the appearance of prostate cancer. The result is a large number of unnecessary biopsies that represent a potential danger for patients and a burden on the healthcare system. The goal of the epiPro project is to identify epigenetic biomarkers of prostate cancer in liquid biopsies that will enable more specific and sensitive diagnostics and more successful differentiation of prostate cancer from BPH.

As part of the clinical processing at Zagreb Clinical Hospital Centre and Sestre milosrdnice Clinical Hospital, anamnestic and clinical data and biological samples of ejaculate and blood of patients with prostate cancer and BPH will be taken. DNA methylation profiles of selected genes on non-cellular DNA (cell-free DNA) will be determined by pyrosequencing in semen and blood, and the expression of certain miRNAs will be determined by digital droplet PCR. Epigenetic profiling will also be performed on tumor tissue samples from the same patients.

More than 100 patients are currently involved in the project. Also, the expression of all predicted miRNAs in blood and ejaculate liquid biopsy samples was successfully analysed. A statistical analysis of the obtained miRNA expression data is underway, which indicates the high potential of one miRNA in differentiating prostate cancer patients from BPH patients based on blood sample analysis. Preparation of samples for pyrosequencing of non-cellular DNA from liquid biopsies samples was also started.

During the first two years of the project, a review scientific paper was published in the journal Epigenomics. The paper critically analysed the experimental designs and methodology used when researching miRNA as a biomarker, especially for prostate cancer, and made significant recommendations for the improvement of the field. Also, five congress abstracts were published at international scientific meetings. In addition to the dissemination of research results, the group strongly supports the education of research assistants in the scientific and technological aspect with the aim of raising the overall knowledge and skills of the group.

Retro-digitization of Croatian grammars refers to the transfer of printed media into computer-readable and searchable text, and in this project it also includes multi-level marking of the transcribed or translated text of Croatian grammars of the pre-Revival period and their association with images of the original text (facsimiles). The user will be able to view facsimiles of the prepared grammars, read the transcribed or translated text of the grammars, and search through it according to given search elements.

The goal of the project is to create a portal of Croatian grammars up to the Illyrian period with images of the originals, metadata and texts of transcriptions/translations of selected grammars, to enable the searchability of grammars at the morphological level by given search elements, to research and describe grammars, and to create an index of Croatian pre-Renaissance grammatical nomenclature. The project aims to intensify research on pre-Renaissance grammatical structures, complete knowledge about the morphological development of the Croatian language in the pre-Renaissance period and knowledge about the development of normative description, and offer knowledge based on the application of modern linguistic disciplines (e.g. cognitive approach). Conclusions on the construction of the Croatian grammatical model will be based on the analysis of the structure of Latin grammars, and the observed corpus of grammars will focus not only on Croatian but also on Latinist research.

The portal will be open access, available to scientists and the general public, and is designed to be developed and grow continuously even after the completion of the project. It would contribute to the preservation of the mentioned materials and heritage and enable further research. Due to the connection with the original (facsimiles), it would offer the possibility of graphic and translation research.

As there is no repository with searchable old Croatian grammars or a model that could be applied to them, this project will simultaneously develop a process and offer a model for future similar research. Considering this way of presenting pre-Renaissance grammars, with the possibility of text searching, the project is pioneering in Croatian, as well as European philology.

PROJECT TITLE:
Retro-digitization and Interpretation of Croatian Grammar Books before Illyrism – RETROGRAM

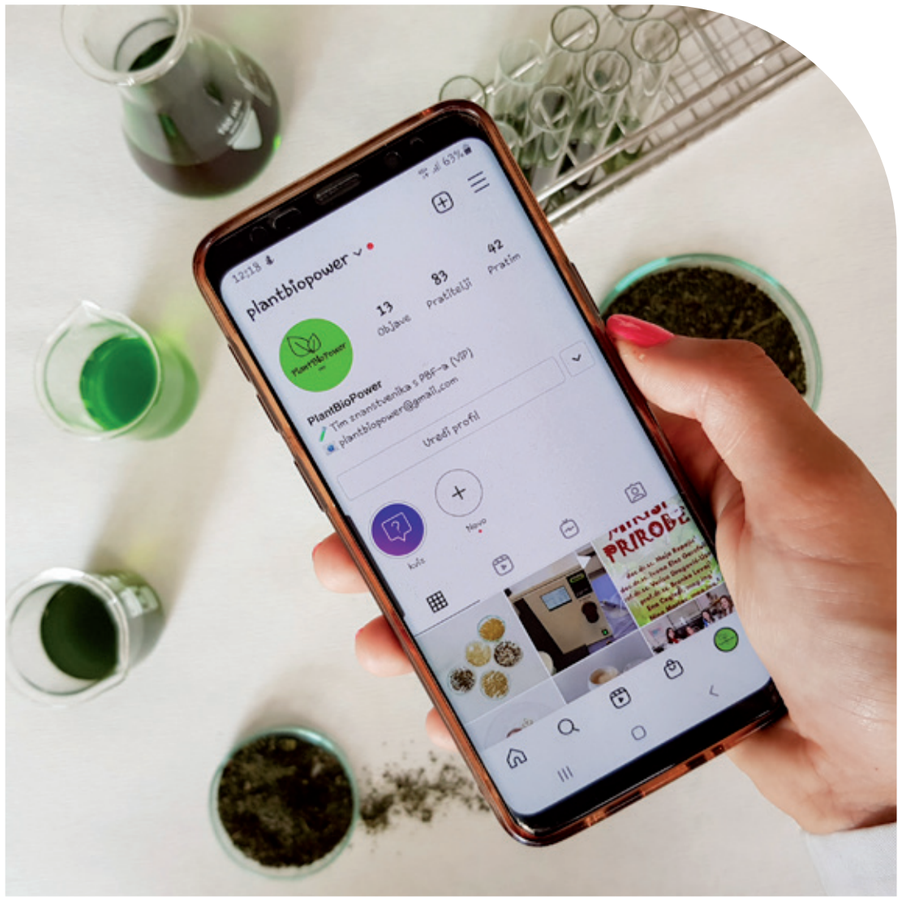
CALL: IP-2018-01

PRINCIPAL INVESTIGATOR:
dr. sc. Marijana Horvat

HOST ORGANIZATION:
Institute for Croatian Language

PROJECT DURATION:
25.11.2019 - 24.11.2023

SCIENTIFIC AREA:
Humanities



YOUNG RESEARCHERS

118 doctoral students employed through the Young Researchers' Career Development Project obtained their doctoral degree in 2023. In this section of the Annual Report we present the research of several new PhDs.

During cell division, the cell forms a division spindle that symmetrically separates the chromosomes into two daughter cells. The spindle is a structure consisting of genetic material, a large number of different proteins and several types of microtubules, including kinetochore fibres that pull chromosomes to the cell poles and overlapping fibres that contribute to the separation of genetic material. The spindle is necessary for the process of cell division, which is why it is important for us to understand the way it is formed, its structure and appearance in different phases of mitosis, and what leads to potential errors in its work. During the preparation of her doctorate, by joining the "NewSpindleForce" project financed by the European Research Council (ERC), Monika Trupinić works on the creation of tumour and non-tumour cell lines necessary for long-term microscopic imaging in order to monitor the division spindle from its formation to the division of chromosomes. Also, for each cell line, it is necessary to create an appropriate recording protocol for that line based on its fluorescent marker, the duration of mitosis, etc. The recordings are then processed in detail using computer methods that need to be created or optimized for the purpose of conducting the desired analyses. Errors in the division of chromosomes and the types of errors that occurred most often will be followed, and an attempt will be made to explain their cause and the manner in which they occurred. This project will greatly contribute to the understanding of the process of cell division, which also contributes to the existing knowledge of tumour division, and in connection with this, the development of antitumor drugs.

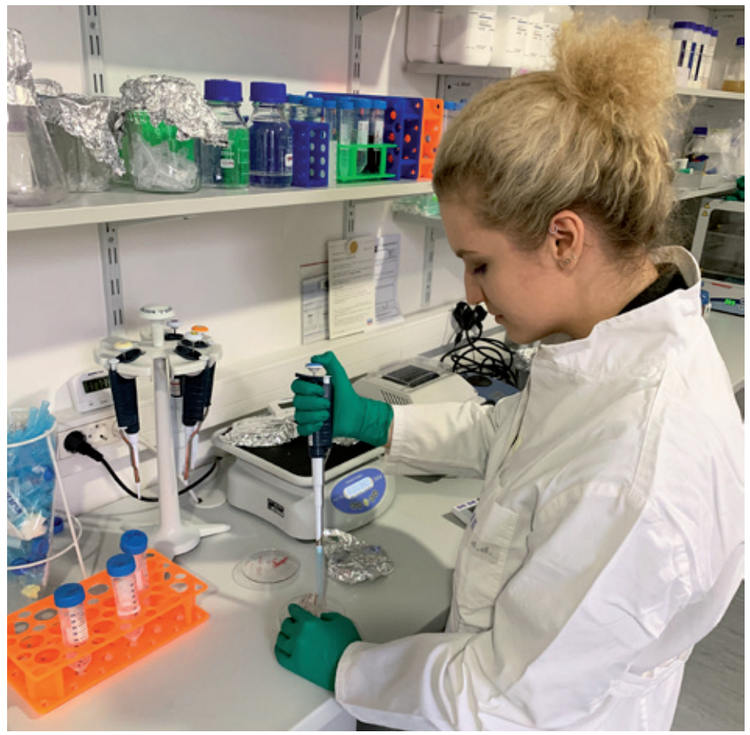
DOCTORAL STUDENT: dr. sc. Monika Trupinić

DISSERTATION TITLE: The role of microtubule-associated proteins in the generation and regulation of spindle shape

SUPERVISOR: prof. dr. sc. Iva Tolić

INSTITUTION: Ruđer Bošković Institute

CALL: DOK-2018-09



DOCTORAL STUDENT: dr. sc. Sara Rossi

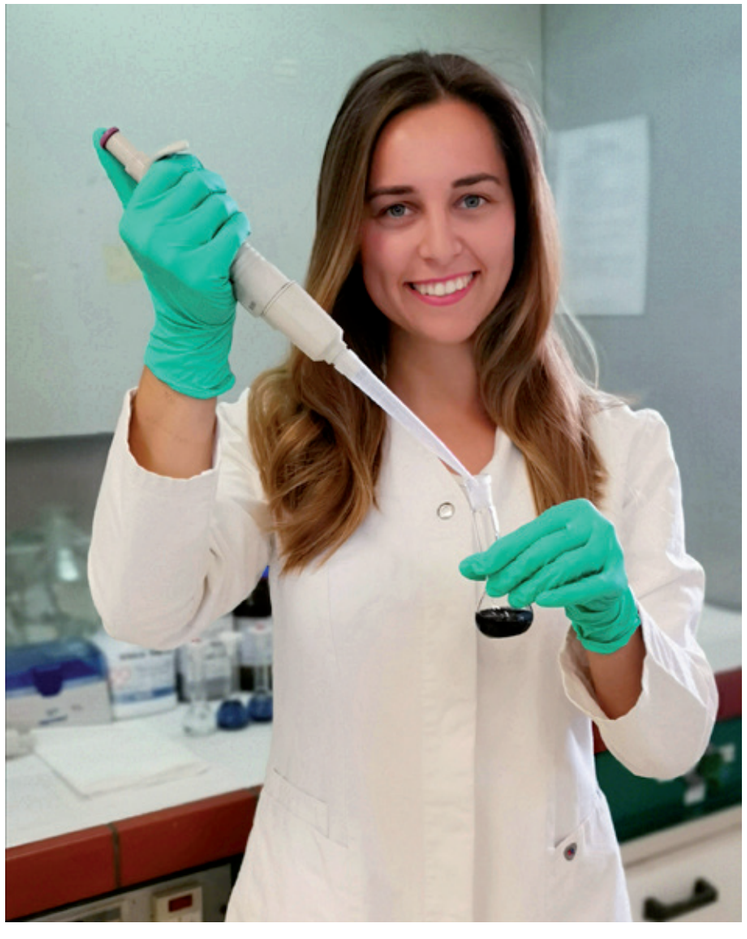
DISSERTATION TITLE: Influence of pre-fermentation heating and maceration time on chemical composition, sensory properties, and concentration of bioactive compounds in 'Teran' wines (Vitis Vinifera L.)

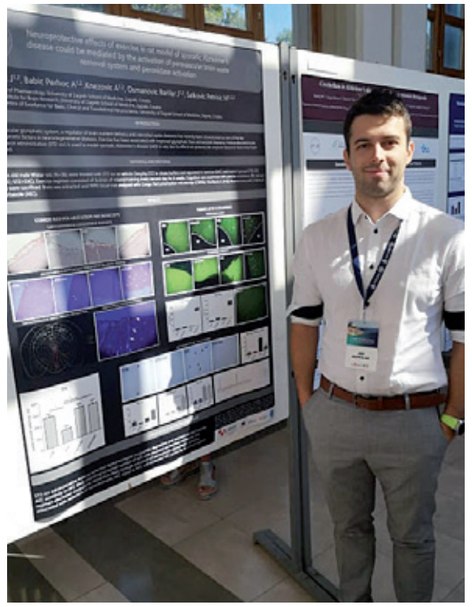
SUPERVISOR: dr. sc. Sanja Radeka

INSTITUTION: Institute for Agriculture and Tourism Poreč

CALL: DOK-2018-09

The composition of wine is very complex and depends on many factors. Apart from grapes, as the source of numerous and often the most important factors in the chemical composition of wine, production technology and ripening conditions play an important role. Different vinification technologies affect the extraction of phenolic and aromatic compounds that determine the character and quality of wine, while phenolic compounds also have a beneficial effect on human health. Considering the lack of objective knowledge about the issue in question, the aim of this work is to investigate the differences in the concentration of bioactive compounds and the qualitative composition of wines of the autochthonous Croatian variety "Teran" (Vitis vinifera L.), produced by different vinification technologies. In Teran wines, the influence of pre-fermentation treatment of heating, prolonged maceration and ripening of wine on sensory properties, basic physical-chemical composition of wine, aromatic compounds, as well as indicators of biological activity of wine: phenolic compounds, vitamins, minerals and antioxidant potential will be examined.





DOCTORAL STUDENT: dr. sc. Jan Homolak

DISSERTATION TITLE: Pathophysiological alterations of gastrointestinal system in animal models of Alzheimer's and Parkinson's disease

SUPERVISOR: prof. dr. sc. Melita Šalković-Petrišić, dr. med.

INSTITUTION: University of Zagreb School of Medicine

CALL: DOK-2018-09

Metabolic dysfunction is currently being investigated as one of the key etiopathogenetic factors of neurodegeneration. Peripheral insulin resistance is a risk factor for the onset of Alzheimer's (AD) and Parkinson's (PD) diseases, and studies on the brains of patients with these diseases indicate altered insulin signaling. Based on the similarities between the molecular patterns of insulin resistance and neurodegeneration, drugs originally developed for the treatment of diabetes are now being investigated as possible therapies for neurodegenerative diseases. Special attention is paid to incretin mimetics, digestive system hormones that have neuroprotective, anti-inflammatory and neurotrophic properties. Although drugs acting on the incretin system are currently in clinical trials for AD and PD, the neuroprotective and therapeutic potential of endogenous incretins is not yet known. Our previous research on a streptozotocin-induced rat model of sporadic Alzheimer's disease showed that early therapy with oral galactose prevents, while delayed therapy alleviates the resulting cognitive deficit depending on the time of administration, and that the effect could be mediated by the secretion of incretins, primarily glucagon-like peptide-1 (GLP- 1).

The aim of this project is to investigate the potential of nutrient-stimulated secretion of endogenous incretins and the understanding of their neuroprotective effects in two rat models of neurodegenerative diseases - the streptozotocin-induced model of sporadic Alzheimer's disease and the rat model of Parkinson's disease based on the intrastriatal administration of 6-hydroxydopamine. Specifically, the project will clarify whether the neuroprotective effect of nutrients (in this case galactose) is mediated solely by activation of the incretin system, a direct effect of galactose, or a combination. Further planned experiments will offer answers to the questions of how the absorption of galactose affects the observed neuroprotective effects and whether there is a therapeutic potential of oral galactose in other models of neurodegenerative diseases such as Parkinson's disease.

DOCTORAL STUDENT: dr. sc. Mia Filipov

DISSERTATION TITLE: Video-based professional development of mathematics and biology teachers

SUPERVISOR: izv. prof. dr. sc. Branko Bognar

INSTITUTION: Josip Juraj Strossmayer University of Osijek, Faculty of Humanities and Social Sciences

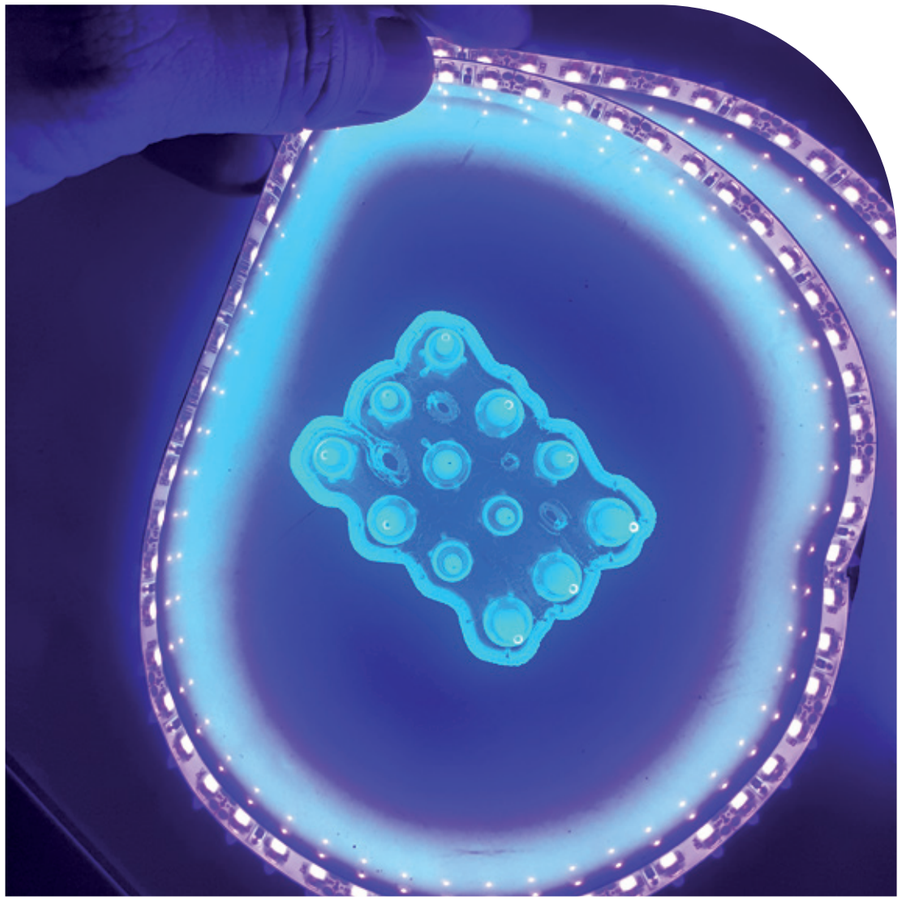
CALL: DOK-2020-01

According to the results of the international examination of knowledge and skills of 15-year-old students – PISA, Croatian students achieve below-average results in the field of reading, science and math literacy. According to meta-analyses by the Australian scientist John Hattie, the "teacher" factor has the greatest effect on successful student learning. This means that the methodical and pedagogical competences of teachers can have a positive effect on students' knowledge and learning achievements. Teacher competencies cannot be developed by chance but can be achieved in structured educational conditions. However, professional development programs that are implemented as part of teachers' lifelong learning are not always organized in such a way that they lead to positive changes in teaching which can improve student achievement. Although international experiences of other researchers can serve as a guide when designing your own professional development program, it is not possible to take ready-made solutions and apply them in our educational system. Therefore, the research team led by Assoc. Prof. Branko Bognar started the project Professional Development of Teachers with the Purpose of Improving the Learning Outcomes in Natural Sciences and Mathematics (SURFPRIMA). The goal of the current phase of the project, in which this doctoral research is being carried out, is to design a quality model of professional training for mathematics and biology teachers, which can contribute to better learning outcomes for Croatian students.

My action research is particularly focused on exploring the possibilities and role of teaching videos as a catalyst for teachers' learning processes, based on which they achieve reflection in communities of practice with other mathematics and/or biology teachers. In addition to teachers, members of the research team, which consists of scientists and experts from the fields of pedagogy, mathematics and biology, also participate in the action phase of the project. This part of the project involves recording the teacher-co-researcher's teaching and online collaboration and collaborative learning in online communities of practice and a teaching discussion forum.

After recording the lessons, the edited recordings are uploaded to YouTube and the Moodle system. At the beginning of the discussion, the teachers whose lesson was recorded first start reflecting on the teaching, after which they are joined in the analysis by other members of the research team and other teacher-co-researchers from the learning community. In doing so, the emphasis is on giving positive and corrective feedback on teaching so that teachers can improve their practice based on it. Teachers are greatly assisted in their learning by the members of the research team, who provide suggestions on how to improve empirically verified features of quality mathematics and/or biology classes. Between the recording sessions, regular meetings of members are held via Zoom, which are a substitute for planned face-to-face meetings in the schools of the teacher-co-researcher. At these virtual meetings of the learning communities, teachers participate in theoretical and practical workshops on the features of quality and effective teaching of mathematics and biology, which are illustrated with video examples of their teaching.

Due to the pandemic, all the learning activities of the teachers and the research team were moved to the online sphere, which proved to be a suitable opportunity for flexible learning in time and space. We have recognized this time of uncertainty and crisis as a challenge to which quality answers can be given precisely by action research, considering that their basic premise is the creative solution of unplanned problems and the positive improvement of existing practice. Regardless of the situation that is limited by epidemiological measures, we believe that teachers who learn together can contribute to the quality of their students' learning.



HRZZ'S ACTIVITIES AND SCIENCE POPULARIZATION

PhD Café

PhD Café is an activity intended for the promotion of young Croatian scientists funded through the Young Researchers' Career Development Project – Training New Doctoral Students and Installation Research Projects. At each event several doctoral students present their doctoral research and results in an informal atmosphere. In 2023, a total of thirteen PhD Café events were held, ten in Zagreb and one in Split, Rijeka and Osijek each. More than 50 doctoral students presented their research at these events.

Zagreb PhD Café, 18/10/2023

Rijeka PhD Café, 21/03/2023

Split PhD Café, 25/04/2023

Osijek PhD Café, 20/06/2023

Final conferences of HRZZ programmes

2023 saw three programmes funded from international sources finish their implementation – ESF-DOK, Research Cooperability and CSRP.

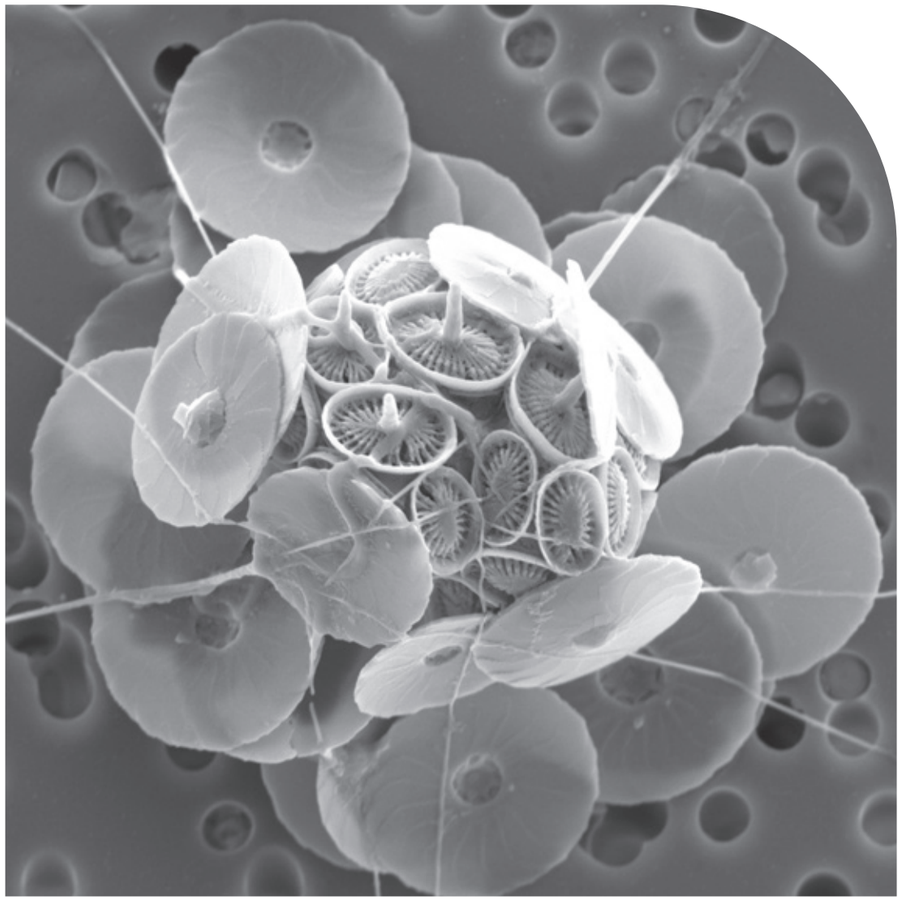
In 2023, HRZZ organised closing conferences of three programmes funded from international sources. HRZZ used these conferences as opportunities to present the results of each programme and to highlight the most successful projects and examples of good practice:

- Young Researchers' Career Development Project – Training New Doctoral Students (DOK-2018-01), funded from the European Social Fund - final conference was held on 10 March 2023 in the Auditorium of the University of Zagreb. Summary of the event is available on HRZZ's website (in Croatian): https://hrzz.hr/zavrsetak-programa-esf-dok-2018-01/

- Cooperation Programme with Croatian Scientists in Diaspora "Research Cooperability" (PZS-2019-02), funded from the European Social Fund – final conference was held on 10 October 2023 at the Croatian Heritage Foundation. For more information about the conference, visit https://hrzz.hr/en/final-conference-of-the-research-cooperability-programme/

- Croatian-Swiss Research Programme 2017– 2023 (CSRP), financed through the Swiss-Croatian Cooperation Programme - final conference was held on 19 October 2023 at the Zagreb Innovation Centre (ZICER), https://hrzz.hr/en/hrzz-hosted-the-final-conference-of-the-croatian-swiss-research-programme/

To mark the closure of these programmes, HRZZ also published a final brochure for each Programme. The brochures are available on HRZZ's website: https://hrzz.hr/o-zakladi/publikacije-i-glasnik/.



FINANCIAL REPORT

Up to 31 December 2021, the status of the Croatian Science Foundation was that of a non-profit organization and the Foundation followed bookkeeping principles pursuant to the Act on financial operations and accounting of non-profit organizations (Official Gazette 121/14). As of 1 January 2022, the Foundation is a budget user of the Croatian State Budget and follows bookkeeping principles pursuant to the Budget Act (OG 144/21).

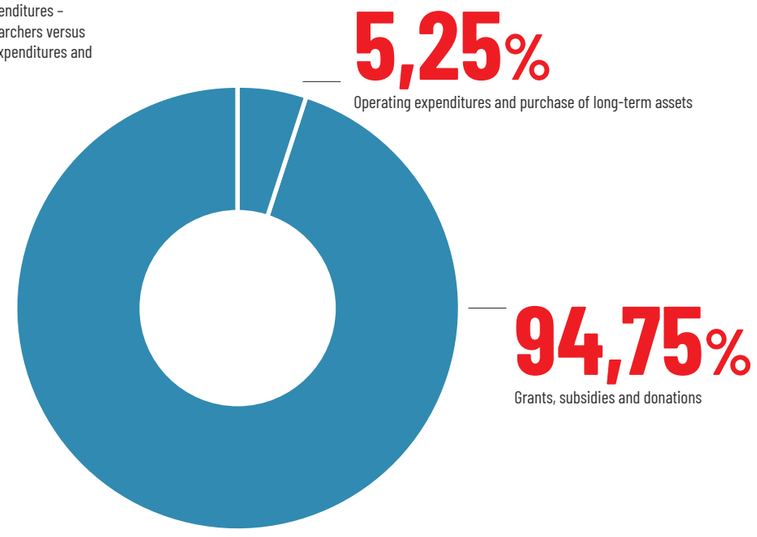
The total assets of the Foundation as on 31 December 2023 amounted to EUR 1,996,343.22, of which EUR 64,134.47 pertains to non-financial assets and EUR 1,932,208.75 to financial assets (EUR 1,327,228.08 of which is the Foundation's underlying asset).

In the period between 1 January and 31 December 2023, the Foundation acquired a total of EUR 29,173,125.01 in revenues – EUR 1,461,627.45 worth of grants from international organizations and EU institutions and bodies, EUR 13,25 revenues from assets, and EUR 27,711,484.31 of revenues from the competent budget for financing regular activities of budget users.

In the same period, the Foundation recorded total expenditures in the amount of EUR 29,256,638.04. Structure of expenditures in 2023 is provided in the table below.

	Category of expenditures	Amount (EUR)
1	Salaries (gross)	895.084,13
2	Other employee expenditures	31.367,56
3	Salary contributions	140.216,16
	TOTAL EMPLOYEE EXPENDITURES	1.066.667,85
4	Reimbursement of employee costs	82.702,21
5	Expenditures for material and energy	22.934,90
6	Expenditures for services	288.989,38
7	Reimbursement of costs for non-employees	15.013,67
8	Other operating expenditures	45.976,84
	TOTAL MATERIAL EXPENDITURES	455.617,00
9	Other financial expenditures	173,64
	TOTAL FINANCIAL EXPENDITURES	173,64
10	Subsidies to commercial subjects outside the public sector	104.160,25
11	Subsidies to commercial subjects outside the public sector from EU funds	84.507,33
	TOTAL SUBSIDIES	188.667,58
12	Transfers between budget users	27.359.315,82
	TOTAL GRANTS PROVIDED WITHIN THE GENERAL BUDGET	27.359.315,82
13	Current donations	171.428,52
	TOTAL OTHER EXPENDITURES	171.428,52
14	Facilities and equipment	14.767,63
	TOTAL EXPENDITURES FOR PURCHASING LONG-TERM ASSETS	14.767,63
	TOTAL EXPENDITURES	**29.256.638,04**

Figure 20. Breakdown of 2023 expenditures – grants for projects and young researchers versus employee expenditures, material expenditures and purchasing long-term assets.



Plan of activities in 2024

In early 2024, the Croatian Science Foundation plans to publish a new Call for Research Projects (IP). This call will also be open for submissions through the Weave initiative, i.e. bilateral and trilateral projects with researchers from Switzerland, Slovenia and Czechia. Just like in previous years, Croatian researchers will also be able to participate in calls of HRZZ's partner agencies – Slovenian Research and Innovation Agency (ARIS), Swiss National Science Foundation (SNSF) and Czech Science Foundation (GAČR). In 2024, HRZZ will also launch new calls for Installation Research Projects (UIP), Young Researchers Career Development (DOK) and Support to Researchers for Applying to European Research Council Programmes (ERC).

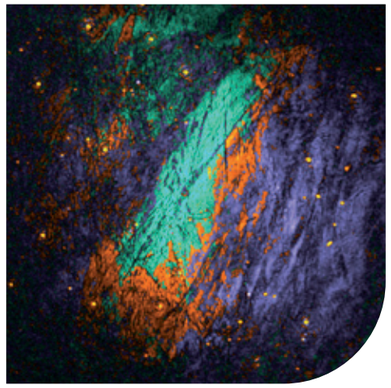
We will also continue implementing programmes through the National Recovery and Resilience Plan (NPOO). HRZZ participates in four NPOO-funded programmes – the Mobility Programme and Young Researchers Career Development Programme (in the role of Beneficiary), Development Research Grants and Targeted Scientific Research (in the role of Implementation Body). Early 2024 will see the evaluation results of the second calls within the programmes Outbound and Inbound Mobility of Senior Research Assistants. The Call Outbound Mobility of Research Assistants will be permanently open in 2024 until all available funds have been allocated. In the first half of 2024, we will also finish the evaluation of applications to the Young Researchers Career Development Programme (DOK-2023-10), which will provide funding for at least 180 new doctoral students. HRZZ is also expected to monitor the implementation of around 37 projects funded through the Targeted Scientific Research programme and between 10 and 13 projects within the Development Research Support.

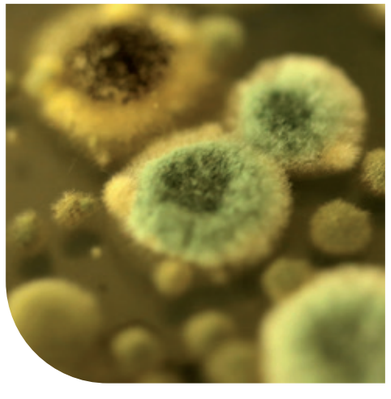
We also plan to maintain an intense level of our international cooperation. As part of the Second Swiss Contribution for the programme period 2023-2029, the Swiss National Science Foundation (SNSF) developed a new funding mechanism called Multilateral Academic Projects (MAPS). MAPS will support collaborative research projects with clearly defined objectives jointly implemented by scientists from Switzerland and their colleagues in Bulgaria, Croatia, Hungary, Poland and Romania. Projects should include a Swiss applicant and between two and five additional partners from the EU-13 countries listed above. The Call is expected to be launched in early 2024.

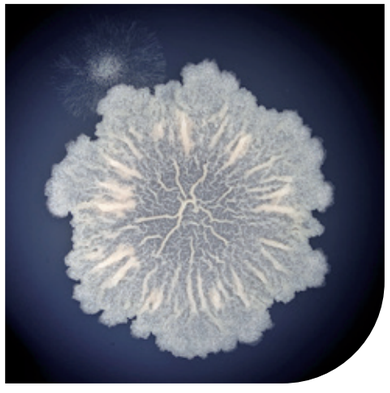
The Trans-Atlantic Platform (T-AP) will start developing a new thematic call in 2024; HRZZ will take part in this process through its engagement in T-AP Forum.

HRZZ will also continue its participation in the CHANSE, QuantERA and BlueBio consortia. CHANSE Call results are expected to be made public in October 2024. The QuantERA network is planning to apply to a new call within the Horizon Europe Framework Programme, which would enable to resume its activities. The BlueBio programme is set to finish in 2024, but the implementation of the transnational projects will be taken over by JPI Oceans, a pan-European platform whose objective is to increase efficiency and impact of research and innovation for sustainable, healthy and productive seas and oceans.

More information on the activities planned in 2024 is available in the Croatian Science Foundation's Work Plan for 2024 available at HRZZ website: https://hrzz.hr/o-zakladi/dokumenti/.







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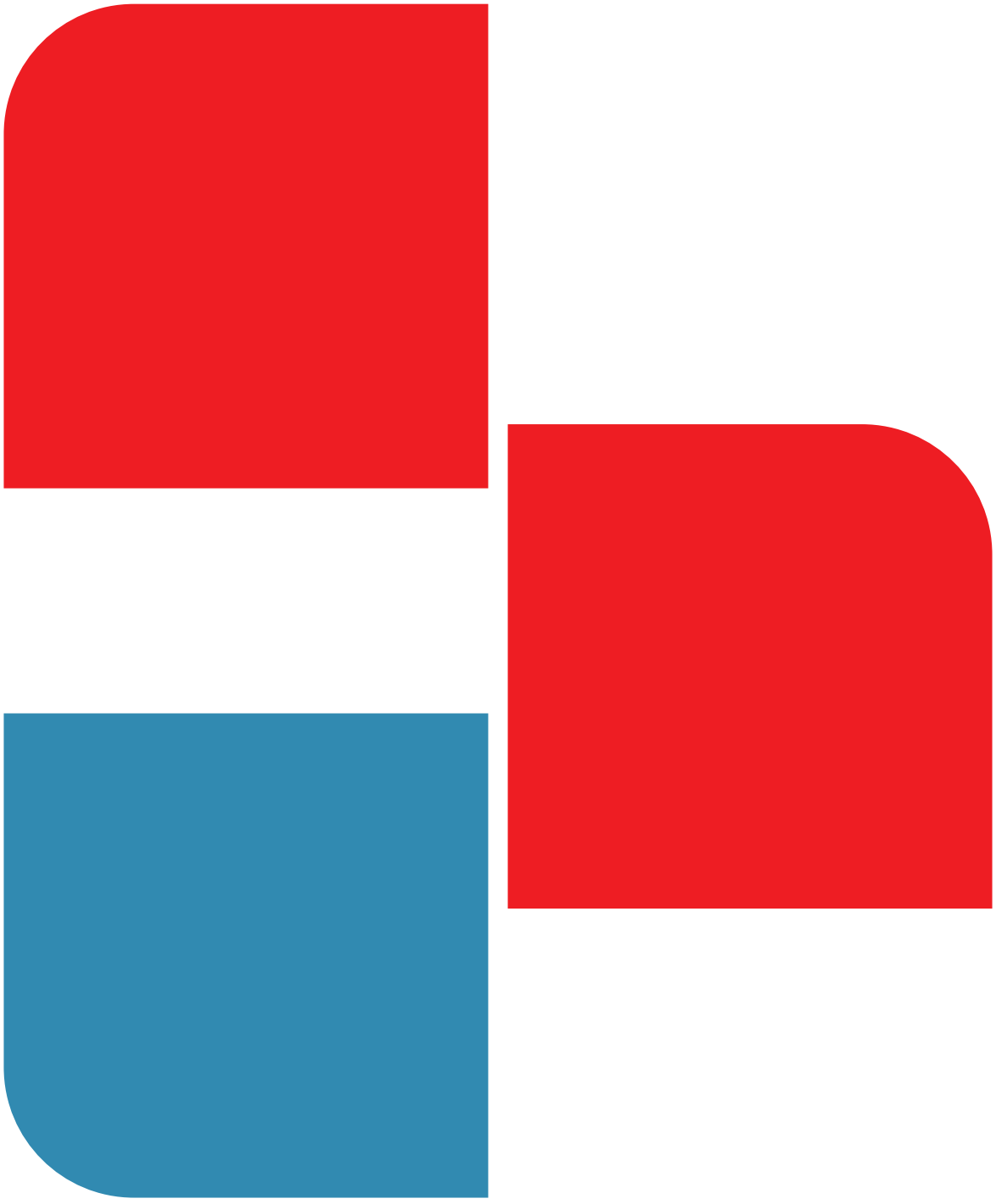

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