CERIC

Central European
Research Infrastructure
Consortium

Report 2024

ERIC established by the European
Commision Implementing Decision
392/2014/EU

Open for Science

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Providing Open Access to Excellent Researchers

The Central European Research Infrastructure Consortium, CERIC-ERIC (in the following, CERIC, or the Consortium), is an integrated multidisciplinary research infrastructure for basic and applied research in materials and biomaterials sciences and nanotechnology.
It operates through a Partner Facility in each of its 8 Member Countries (Austria, Croatia, Czech Republic, Hungary, Italy, Poland, Romania and Slovenia) which contribute through these facilities. CERIC allows open access to the best researchers from all over the world through a single-entry point and international evaluation of the proposed research.
The Partner Facilities (PFs), which are periodically evaluated by the International Scientific and Technical Advisory Committee (ISTAC), are strongly complementary to each other. They allow the integrated use of analytical and synthesis techniques based on different microscopic probes for nano-level science and technology. Available methods include the use of photons, electrons, ions and neutrons in X-ray spectroscopy, diffraction and imaging, light scattering, ion beam analysis, high-resolution electron microscopy and neutron scattering.

Andrew Harrison
CERIC Executive Director

Dear Colleagues, Partners and Friends,

I have the privilege and pleasure to present the 2024 Annual Report of CERIC-ERIC, taking up the baton from Jana Kolar after 9 dynamic years of growth and achievement under her leadership. CERIC started operations 10 years ago based on a unique concept whereby a collection of Ministries across Central Europe offered and supported open access to the research community to some of their best science facilities, and is now a distributed yet coherent research infrastructure with global reach and impact.

This year's report showcases the excellent science enabled by CERIC, much of which exploits one of its key characteristics and strengths, namely facilitating access to multiple techniques through a single proposal. This enables more complex scientific challenges to be addressed effectively and boosts the delivery of high impact science in countries or research communities that have little experience of user facilities. CERIC also encourages and supports in-house research by staff at its Facilities, providing a powerful inspiration for scientists and engineers to continue to develop technical capability for the wider user community, and a strong motivating factor for recruitment and retention of personnel.

The past year has also seen strong growth or plans for significant enhancement of instrumentation at all CERIC Facilities, from large-scale upgrades of facilities such as the Elettra 2.0 upgrade of the storage ring, starting in 2025, to smaller but highly-effective development of equipment that enable operando studies of materials processes, for example fuel cells that can be inserted into X-ray beamlines. Such improvements, together with a very active programme of engagement and training of students who may become future users or instrument scientists points to a bright future for CERIC, with continued growth and delivery of science with impact for the decade to come.

I extend my sincere thanks to everyone who makes CERIC-ERIC the success it is, across borders, disciplines, and generations.

Dr. Andrew Harrison
Executive Director

2024 Key Achievements

Advancing Scientific Discovery

- Implementation of two calls for free open access to which 317 proposals requesting the use of 433 instruments, were received.
- Proposals submitted from 37 countries and all continents.
- Continuous fast-track access for feasibility studies, and possibility to perform experiments via remote access.
- Positive evaluation of the progress of CERIC internal transnational research projects.
- Participation in externally funded projects: IMPRESS, ReMade@ARI, OPVStability, ERIC Forum, OSCARS.

Developing and strengthening CERIC's portfolio

- Positive evaluation of the Hungarian and Polish PFs by international teams of experts led by CERIC's ISTAC.
- Infrastructure upgrade: new accelerator building being constructed at the Croatian PF, equipment upgrade of the SPL and HTC laboratories at the Czech PF, modernisation work ongoing at the Hungarian PF, three new instruments installed at the Italian PF, two new beamlines (PolyX and CIRI) constructed at the Polish PF, new 600 MHz NMR spectrometer purchased at the Slovenian PF.
- New instruments added to the CERIC open access offer: Poly-X at the Polish PF and IUVS OFF at the Italian PF.
- Four projects funded via the CERIC Call for Expression of Interest have been completed.
- Zdravko Siketić appointed as new Director of the Croatian PF.

Nurturing Talent and Public Engagement

- ~600 hours of training delivered to CERIC staff.
- Contribution to the capacity building of RI staff.
- +70 members of the CERIC community gathered at Science@CERIC 2024.
- 80 high-school pupils trained in the frame of the PaGES 8 project.
- 9 CERIC-supported PhD projects completed.
- Host one professional from the University of Gdańsk seconded to CERIC in the frame of the ERA-Shuttle project to act as university-industry liaison.
- Engagement with ~900 people through science dissemination events: Trieste Next, EU Researchers' Night, ESOF 2024.

Cultivating Innovation and Industry Cooperation

- Promotion of CERIC services for the industry at major events: EIC Summit, VIVATECH, Re-Battery 2024, European Hydrogen Week.
- Engagement with ~100 industrial stakeholders in a workshop on hydrogen research organised at BSBF 2024.
- New ongoing negotiations with the companies in the energy and pharma sector for commercial access to CERIC facilities.
- 10% of the articles from open access research related to industry.

Other EU Priorities and impact

- First draft of the CERIC impact assessment report produced.
- Report on the impact of CERIC in Austria presented during the visit to the CERIC premises, of the Austrian Federal Minister for Education, Science, and Research
- Preparatory work towards a European employment contract.
- Contribution to ERIC Forum's deliverable D12.1 released in 2024, and to be used by the European Commission (EC) for the revision of the ERIC practical guidelines.

Policy, Operations and Finance

- Update of the CERIC Internal Rules of Procedure.
- New CERIC Executive Director appointed.
- Development of the CERIC's Proposal Management System began in 2024.
- Financial and in-kind annual account.

Executive Summary

In 2024, CERIC continued to excel across its strategic areas, encompassing scientific research, innovation, industry liaison, and policy development. With respect to open access, the number of proposals received remained stable (Table 1), while the instrument offering continued expanding with the addition of new facilities and techniques.

Headline Indicators	2021	2022	2023	2024	% Change 2024-2023
Proposals received	298	343	333	317	-4.8
Number of papers	109	120	109	142	30.3
Share of papers among 10% top cited[1]	5,1%	9,9%	12,2%	12,7	

Table 1 Headline indicators for 2021-2024 and changes in the last reported year.

CERIC's 10th Anniversary

CERIC marked its 10th anniversary in 2024, with events in Lecce, Brussels, and at its PFs in Hungary and Croatia. The Brussels event gathered EU and RI leaders to reflect on CERIC's impact on science and innovation. National celebrations showcased achievements, future opportunities, and Member Countries' engagement and benefits from CERIC's open access model.

Advancing Scientific Discovery

In 2024, CERIC continued to enhance scientific research by offering open access to over 60 techniques across its PFs and Associated Facilities (AFs). In response to the two open call for proposals launched in 2024, scientists worldwide submitted 317 proposals, corresponding to 433 single-instrument requests, with a very slight decrease (-4.8%) in applications compared to the previous year.
205 proposals were selected, for a total of 965 days of experiments. CERIC's international reach remained strong, with participation from 37 countries, and 13% of experiments conducted remotely. The number of scientific publications (129) by CERIC users increased by 30.3%, and 12.7% of CERIC's papers were in the top 10% most cited in their fields. Fast-track access remained available for feasibility studies, and for commissioning.
CERIC also played an active role in externally funded projects, including Horizon Europe (HE) initiatives, such as OSCARS, ERIC Forum 2, IMPRESS, ReMade@ARI, and the Marie Skłodowska-Curie Action OPV Stability.
These projects focus on advancing Open Science practices, fostering collaboration, contributing to the circular economy, and driving research on sustainable materials, such as improving the stability of organic photovoltaics (OPVs), promoting efficient recycling technologies, and supporting new energy and material innovations, as well as enhancing the impact and sustainability of European RIs by facilitating the development of common policies and strategies.
Through these initiatives, CERIC continues to strengthen its role in scientific development and international partnerships within the European Research Area (ERA).

Developing and strengthening CERIC's portfolio

CERIC has continued enhancing its infrastructure and integrating national multidisciplinary research facilities into a unique EU-level distributed RI.
Through various initiatives, such as the 2022 Call for Expression of Interest (EoI) and the related joint research projects involving its PFs, CERIC has provided funding to its PFs, for research grants and infrastructure upgrade, including the development of advanced techniques for hydrogen and battery research.
Four out of the twenty projects selected and funded via the EoI call were completed in 2024.
Moreover, a new funding model - including annual membership fees from Member Countries - was introduced in 2024 to foster infrastructure integration and development.
Key projects, such as the installation of new instruments at the Italian and Slovenian PFs, the implementation of a new accelerator facility at the Croatian PF and the continued modernisation of the Hungarian neutron facilities, will improve the overall scientific offerings and infrastructure across CERIC facilities and Member Countries.
In 2024, CERIC continued its commitment to monitoring and enhancing the quality of its infrastructure and services, with the routine evaluation of the Hungarian and Polish PFs conducted to ensure compliance with the highest standards and further improvement.
Also, the Consortium kept expanding its open access offer, with the Poly-X beamline at the SOLARIS synchrotron in Krakow, which was added to its portfolio of instruments and techniques, to better serve the scientific community. Moreover, the IUVS OFF instrument at the Elettra synchrotron in Trieste was included among the instruments accessible via fast-track under commissioning.

Nurturing Talent and Public Engagement

In 2024, CERIC reinforced its commitment to talent development and science communication through a wide range of training, mobility and outreach initiatives. Nearly 600 hours of staff training were delivered on topics from AI to impact assessment, while leadership coaching strengthened CERIC's management.
CERIC also invested in capacity building at RIs and co-organised the Science@CERIC 2024 event, gathering over 70 participants, including CERIC users, directors and PhD students.
Education activities, such as the eighth edition of the PaGES project, trained 80 high-school pupils with lectures on project management and communication, and hands-on activities at the synchrotron beamlines in Trieste to conduct a scientific experiment and present the results to their fellow students and teachers. Nine of the CERIC-funded PhDs completed their research projects, and 20 articles were published in peer-reviewed scientific journals.
Moreover, in the frame of the ERA-Shuttle project, staff exchanges promoted knowledge circulation in Widening Countries.
CERIC also reached broad audiences through participation in major science events such as Trieste Next, ESOF, and the European Researchers' Night, and contributed to RI engagement strategies via the PAERI conference, ensuring visibility of its research and societal impact.

Cultivating Innovation and Industry Cooperation

In 2024, CERIC advanced its industrial engagement strategy through its Industrial Liaison Office (ILO), enhancing collaboration with the private sector.
The Consortium continued strengthening its ties with industry by promoting its services at major events, such as the European Innovation Council (EIC) Summit, VIVATECH, Re-Battery 2024, and European Hydrogen Week. It also co-organised a hydrogen-focused workshop at the Big Science Business Forum - BSBF 2024, and supported new feasibility tests and commercial agreements with companies in the pharmaceutial and energy sectors.
Industrial relevance grew, with 10% of 2024 publications linked with the industry, and 2% of access tied to industrial projects, confirming CERIC's growing impact on Europe's innovation ecosystem.

Other EU priorities and impact

CERIC has significantly contributed to EU priorities by enabling open access to advanced research facilities, fostering innovation, and supporting scientific excellence. From 2015 to 2024, it supported 715 peer-reviewed scientific publications, with high citation impact and strong links to industry and patents.
CERIC enhanced research capacity in its Member Countries and advanced technologies relevant, among others, to societal challenges in the fields of health, energy, electronics and sensors, and applied materials.
Moreover, in 2024, in the frame of the ERIC Forum 2 project, CERIC helped define a common European employment contract model and supported the update of the ERIC implementation guidelines, with the aim of reinforcing legal clarity and researcher mobility across RIs and ERICs in Europe.

Operations and Finance

CERIC ended the year 2024 with a new Executive Director - Prof. Andrew Harrison - appointed by the General Assembly (GA).
With respect to user access operations, the Consortium made notable advancements in the development of its own Proposal Management System - designed to streamline experiment administration, enhancing efficiency and user experience across CERIC's facilities.
The final section of this report provides a comprehensive overview of the financial and economic status of the Consortium for the year 2024. This overview is presented in accordance with the International Public Sector Accounting Standards (IPSAS) under the accrual basis of accounting. This financial reporting ensures transparency and provides a clear picture of CERIC's financial health to stakeholders and members alike.

[1]Percentage of publications based on research performed using facilities/resources of the RI that, compared with the publications in the same field and in the same year, belong to the top 10% most frequently cited.

About CERIC

CERIC* has established and has been operating a multidisciplinary distributed RI on a non-economic basis.

Mission

CERIC is a research infrastructure integrating and providing open access to some of the best facilities in Europe, to help science and industry advance in all fields of materials, biomaterials and nanotechnology. It enables the delivery of innovative solutions to societal challenges in the fields of energy, health, food, cultural heritage and more.

Vision

CERIC co-creates the European Research Area (ERA) by enabling the best global researchers to realize their ideas in a multicultural research environment with a worldwide reach. By expanding insight into materials on the nanoscale, CERIC contributes to solving contemporary societal challenges.

*in line with the ERIC Regulation (EC No 723/2009)

CERIC integrates leading national research institutes into a unique international infrastructure, having its statutory seat in Trieste – Italy, and its nodes distributed across its Member Countries - Austria, Croatia, Czech Republic, Hungary, Poland, Romania and Slovenia (Serbia is currently pending full membership).

Each Member Country contributes in kind to CERIC by making available and supporting a Partner Facility (PF) which provides users from all over the world outreach and access to over 60 techniques based on the use of electrons, ions, neutrons and photons for the analysis and synthesis of materials. A number of Associated Facilities (AFs) in France, Italy and the Netherlands complement the offer. Access to all PFs and AFs is managed through a single-entry point on the basis of competitive peer-reviewed scientific excellence, or for commercial users, who may need to keep data and results confidential, it may be purchased at the market rate for the particular infrastructure required. The PFs are strongly complementary to each other and act as a whole as an international agency providing support to the best researchers and research projects, contributing access to advanced analytical and synthesis facilities.

The governance structure involves ministerial representatives of the Member Countries, as well as the directors of the PFs. CERIC management and research activities are distributed in the participating countries and cover administration, communication, technology transfer and project management. A common support system allows the distributed staff to operate in an integrated way for transnational and cooperative projects and joint ventures.

CERIC Partner Facilities, Instruments and Techniques

AUSTRIA

Graz University of Technology

is dedicated to the structural characterisation of nanosystems with scattering techniques covering topics such as advanced materials, (bio-)polymers, proteins in solids, surfaces, liquids and in the gas phase. The facility provides access to its light and X-ray scattering laboratories, as well as to the Austrian SAXS beamline and Deep X-ray Lithography beamline, both at Elettra.

CROATIA

Ruđer Bošković Institute

develops and provides access to ion beam techniques for materials' modification and characterisation, such as PIXE and RBS, as well as a heavy ion microprobe, dual beam irradiation chamber with RBS/channelling, and TOF ERDA spectrometer.

CZECH REPUBLIC

Charles University Prague

has expertise in surface and materials science, electrochemistry and hydrogen technologies. It offers access to the Surface Science Laboratory and the Materials Science Beamline at the synchrotron Elettra for photoelectron and X-ray absorption spectroscopies, low energy electron diffraction and microscopy techniques, as well as to the Hydrogen Technology Centre to study materials and their assemblies in hydrogen fuel cells and water electrolysers, also under operating conditions.

HUNGARY

Budapest Neutron Centre

performs and offers R&D in nuclear science and technology, studying the interaction of radiation with matter and performing isotope and nuclear chemistry, radiography and radiation chemistry, surface chemistry and catalysis. Neutron scattering instruments allow investigation of the microscopic properties of solids, liquids, soft materials, biological objects and condensed matter.

ITALY

Elettra Sincrotrone Trieste

offers a third-generation synchrotron light source specialised in the fine analysis of matter. Its beamlines cover a wide variety of experimental techniques and scientific fields, including photoemission and spectroscopy, crystallography, imaging at micro and nanoscale, X-ray imaging, X-ray and IR microscopy, etc. The investigated research fields span materials science, surface science, solid-state chemistry, atomic and molecular physics, as well as biology, medicine and cultural heritage.

POLAND

National Synchrotron Radiation Centre SOLARIS

offers X-ray photoemission, absorption spectroscopy of soft, tender and hard X-rays, scanning transmission X-ray microscopy, photoemission electron microscopy, angle- and spin-resolved photoelectron spectroscopy, hard X-ray microimaging and microspectroscopy, and the cryo transmission electron microscope enabling researchers to look at the macromolecules almost in their natural environment.

ROMANIA

National Institute of Materials Physics

offers access to high-resolution transmission electron microscopy and electron paramagnetic resonance laboratories for research in solid state physics and materials science, including the synthesis and characterisation of advanced materials for applications in microelectronics, catalysis, energy industry and ICT.

SLOVENIA

National Institute of Chemistry

offers NMR spectroscopy for chemical analysis and identification, for determining 3D structures and studying the dynamics of small and larger bio-macro-molecules, for tracking chemical reactions in analytical and bioanalytical procedures, for studying polycrystallinity and identifying metabolites and various amorphous forms.

Associated Facilities

EUROPEAN COMMISSION

European Commission's Joint Research Centre (JRC) Nanobiotechnology Laboratory in Ispra
Offers facilities and instruments for interdisciplinary studies with a special focus on nanomaterials, nanomedicines, advanced materials, micro(nano)plastics, and innovative technologies for health.

European Commission's Joint Research Centre (JRC) Fuel Cell and Electrolyser Testing Facility (FCTEST)
Which allows testing of low and high-temperature PEM fuel cell and electrolysis test stations in single cell and stack.

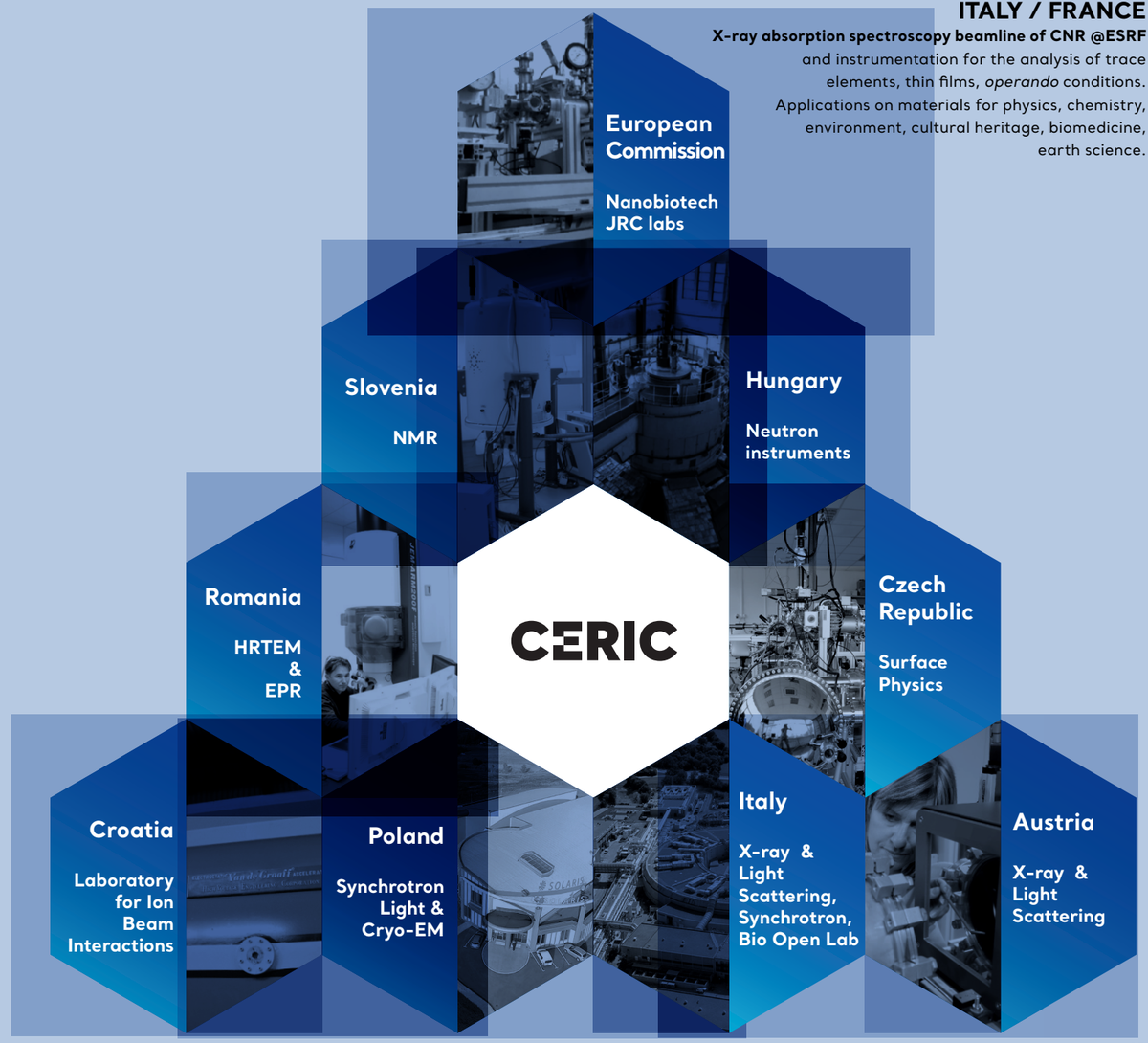
European Commission's Joint Research Centre (JRC) Battery Energy Storage Testing Laboratory (BESTEST)
Allowing to analyse the performance of battery materials and devices by cycling them under controlled environmental conditions.

ITALY

Bio Open Lab (BOL) in Salento, Salerno and Trieste
Providing an integrated system of research equipment and instruments dedicated to investigations in the field of biological and biomedical research.

ITALY / FRANCE

X-ray absorption spectroscopy beamline of CNR @ESRF
and instrumentation for the analysis of trace elements, thin films, *operando* conditions. Applications on materials for physics, chemistry, environment, cultural heritage, biomedicine, earth science.



CERIC's 10th Anniversary

Official celebration in Brussels

In 2024, CERIC turned ten years old. The first celebration of its anniversary took place at the Science@ CERIC event held in October in Lecce (see page 47), which mainly addressed CERIC's scientific community.

The main celebration, open to all CERIC major stakeholders, was then organised later in November in Brussels. The event - opened by Ambassador Stefano Verrecchia (Deputy Permanent Representative of Italy to the EU) and Carlo Rizzuto (Chair of the CERIC GA) - brought together forty participants, including representatives of the European Commission (EC) and EU Countries, leading European institutions and RIs.

In the first panel, *RIs Policy: Reflections and Future Pathways,* panellists reflected on the achievements and impacts of RIs, Technology Infrastructures and ERICs - including CERIC, exploring different ways to enhance their effectiveness in the future, including policies at both the national and EC level.

The second panel *Advancing Science at CERIC: Current Successes and Future Potential,* highlighted the scientific achievements and impacts of CERIC over the past decade and served to discuss the challenges and opportunities that will shape its future.

As stated by CERIC's former Executive Director, Jana Kolar, '*Since its establishment, CERIC-ERIC has significantly boosted scientific productivity and quality across Member Countries strengthening research capacity, fostering technological innovation, and expanding EU collaborations. By facilitating excellent, diverse and impactful research, we're proud to be driving scientific excellence and innovation across Europe*'.

Following the event, other events celebrating CERIC's 10th anniversary have been scheduled between 2024 and 2025 at its PFs to address the related national communities.

CERIC's 10th anniversary celebrations at the Hungarian and Croatian Partner Facilities

The first CERIC PF that organised a local event to celebrate CERIC's 10th anniversary was the Hungarian one, the Budapest Neutron Centre (BNC) at the HUN-REN Centre for Energy Research.
The event took place on November 25th, 2024, to present research and innovation in the fields of materials science, archaeology and natural sciences with a series of lectures focused on the techniques available at BNC and their utility in interdisciplinary research. Other topics were discussed, such as waste management with a circular economy approach, and heritage science studies at BNC.

On December 6th, the Ruđer Bošković Institute (RBI), representing Croatia in CERIC, marked the 10th anniversary of CERIC with another event, celebrating the Consortium's achievements and its transformative impact on European research.
A number of contributions from leading scientists showcased cutting-edge research enabled by both RBI, and other CERIC PFs. Overall, the event's programme fostered discussions on Croatia's pivotal role in the consortium, celebrating not only its achievements but also the future possibilities for scientific discovery and collaboration within CERIC.

Dr. Milko Jakšić, former director of the CERIC PF at RBI, emphasized Croatia's key contributions to CERIC, pointing out that *"the Consortium has been instrumental in expanding research opportunities across Europe"*. In the last 10 years, international researchers involved in fifty successful proposals were granted access to the ion-based instruments and techniques at RBI, in research domains spanning materials science, biology, medicine, environment and cultural heritage.
As stated by Dr. Jakšić, *"Croatian scientists have also benefited from CERIC's offer. Since the setup of the Consortium, 109 Croatian users have been granted access to the available facilities, making the Croatian research community one of the key beneficiaries of CERIC"*. Most Croatian users (35%) requested access to the Austrian facility at the Technical University in Graz, followed by the Italian PF (23%) at Elettra Sincrotrone Trieste (in the following, Elettra), the Croatian RBI (17%), and the Slovenian NMR facility in Ljubljana (14%).
Dr. Jakšić concluded with enthusiasm: *"With ongoing upgrades of the RBI accelerator facility, we are excited to continue playing our active role in driving CERIC's growth and increasing its scientific impact*".

During the event, Jelena Ilić Dreven, Head of the Department for Preparation, Monitoring, and Implementation of Science and Technology Policies at the Ministry of Science, Education and Youth of the Republic of Croatia, after recalling Croatian contribution to CERIC since the Consortium's inception, stated: "*Croatia's vision, outlined in our RI Development Roadmap, is to excel in internationally competitive research, strengthen international cooperation, and enhance the visibility of Croatian science, economy, and society. CERIC is a prime example of this vision in action, fostering collaboration across borders and advancing our shared scientific goals*".

1

Advancing Scientific Discovery

The objectives of CERIC, as described in the Statutes, are to:

- Contribute to European top-level research and technological development and demonstration programmes and projects, thus representing an added value for the development of the European Research Area (ERA) and its innovation potential while stimulating a beneficial impact on the scientific, industrial and economic development.
- Further the integration of national Facilities operating mainly in the Central European Area, into a unique, EU-level distributed RI, open to researchers at world level.
- Make optimum use of resources and know-how by coordinating research and development of relevant technologies, by promoting and coordinating joint training of scientific and technical personnel and young researchers, and by collaborating with neighbouring communities and industry.

Main Achievements in 2024

1. **Implementation of two calls for free open access to which 317 proposals requesting the use of 433 instruments, were received.**
2. **Proposals submitted from 37 countries and all continents.**
3. **Continuous fast-track access for feasibility studies, and possibility to perform experiments via remote access.**
4. **Positive evaluation of the progress of CERIC internal transnational research projects.**
5. **Participation in externally funded projects: IMPRESS, ReMade@ARI, OPVStability, ERIC Forum, OSCARS.**

Open Access

CERIC's main aim is to enable excellent science, both both as a service to international users and as an in-house activity. This is achieved mainly by providing merit-based open access to its research facilities and promoting internal research.

In 2024, CERIC launched two calls for proposals to use the Consortium's research instruments: 317 proposals were received (Figure 1). Given their multi-technique character, this corresponds to 433 single-instrument proposals. The number of received applications slightly decreased (-4.8%) compared to the previous year.

205 proposals, equivalent to 257 single-instrument proposals, were selected (Figure 2) for the use of the over 60 techniques available in the CERIC open access offer, to perform experiments for a total of 965 days. In addition to physical access to the CERIC facilities, all facilities continued to offer the possibility of performing measurements remotely through sample mailing. In 2024, 13% of experiments were conducted in this modality.

Figure 1
Number of proposals and requested methods

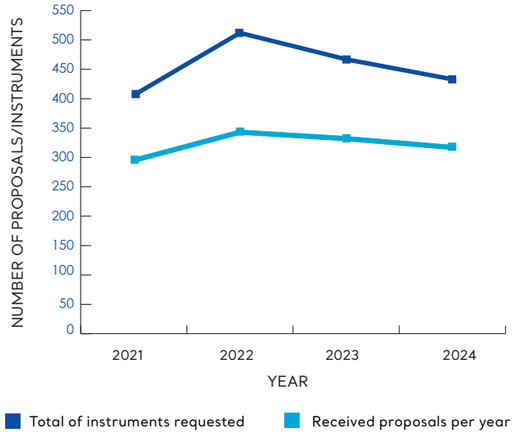
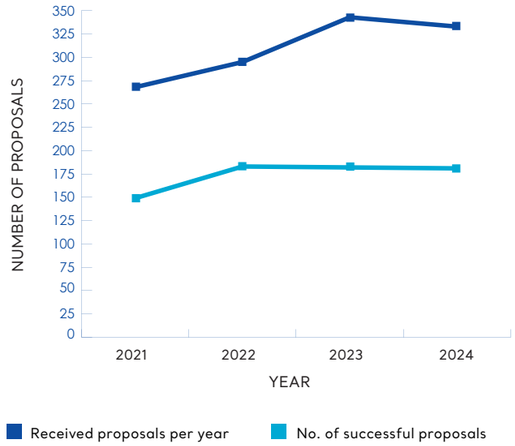
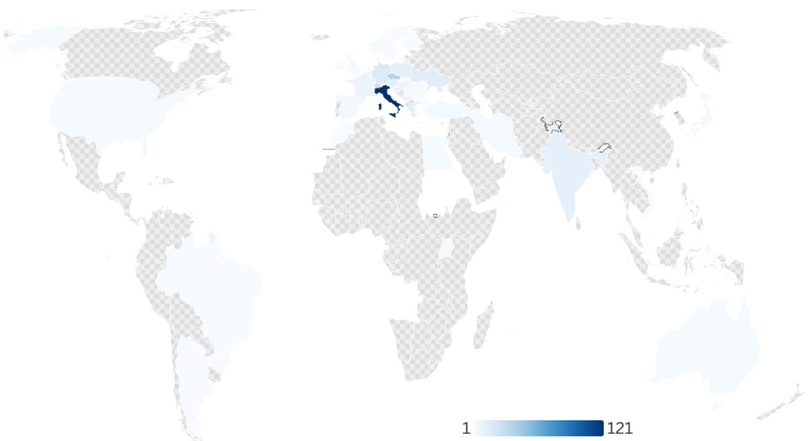


Figure 2
Number of received and successful proposals per year

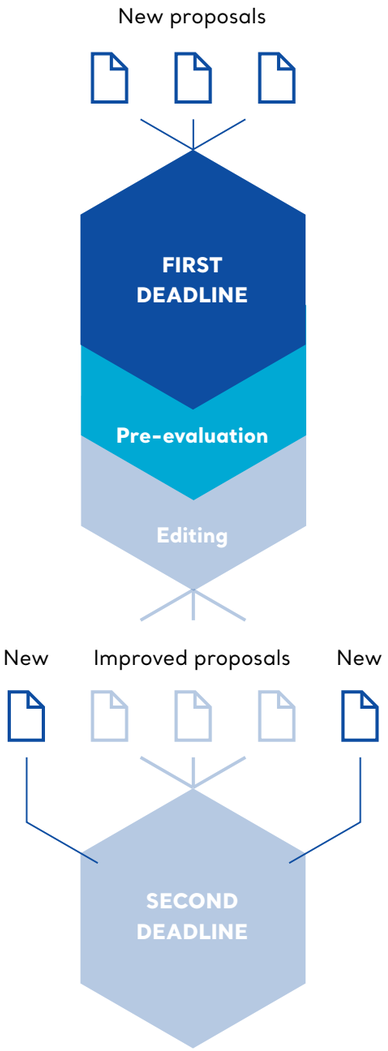


CERIC remains a highly internationalised RI, with principal investigators from all continents in 2024 (Figure 3). Proposals came from 37 countries, of which 65% are CERIC Member Countries, and 18% are non-EU countries.

Figure 3
No. of proposals by country

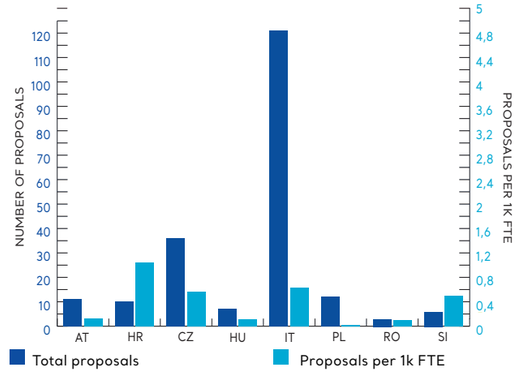


- **2 calls for proposals**
- **337 proposals received**
- **Research groups from 37 countries**
- **257 allocated requests**



The majority (65%) of submitted proposals in 2024 came from CERIC Member Countries, as in the previous year. The most active researchers, in relation to the fulltime employees in Research & Development in a country, are from Croatia, followed by Italy and Czech Republic (Figure 4).

Figure 4
Submited proposals per 1K full-time employees (FTE) in R&D in Member Countries



In 2024, 44% of the principal investigators and 40% of the researchers who performed the measurements at the facilities were women (Figure 5).

Figure 5
Gender distribution of CERIC users

Quantity and quality of the research output

In 2024, the total number of publications arising from data gathered at CERIC's facilities increased by 30.3% in comparison to the preceding year. The average Impact Factor (IF) slightly decreased (-7.6%) if compared to 2023, with a value of 7.8. However, it is important to note that this decrease is not significant and that IF is not an ideal indicator of output quality.
Also in 2024, CERIC collected data on the most cited publications, expressed as the share of CERIC's papers among the top 10% (figure 6) and top 20% most frequently cited ones. In 2024, 12.7% of CERIC papers are in the top 10% most cited studies in their related fields, which is a significant increase compared to the previous year.

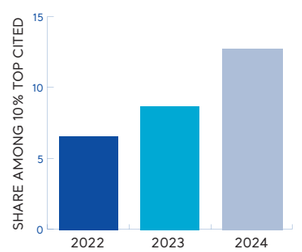


Figure 6
Share of publications, based on the research performed using facilities/resources of RIs, in top 10% most cited papers among a comparable field in the latest 3 years. All the publications tied at the threshold of top10% are taken in consideration.

Fast Track Access

Fast Track Access stayed open throughout the whole year 2024, allowing access to a set of relevant instruments for research and testing to be scheduled within one month from the submission of the proposal, based on an evaluation performed by the PF. During the year, 32 proposals were received for this access mode. A wide number of techniques at the Austrian, Czech, Italian, and Slovenian PFs have been devoted to this purpose.

New instruments available via open access

In 2024, new instruments and techniques have been added to the CERIC open access offer, through both the new CERIC Associated Facilities (AFs) in Italy, and the Italian and Polish PFs.
Such instruments include the following: Accelerator Mass Spectrometry-Isotope Ratio Mass Spectrometry for radiocarbon dating (AMS-IRMS) at the University of Salento, as part of the CERIC AF Bio Open Lab; X-ray Microimaging and Microspectroscopy - PolyX as part of the Polish PF.
At the Italian PF, the synchrotron beamline IUVS-Offline, has been included again in the CERIC portfolio in its upgraded setup.

International Scientific and Technical Advisory Committee - ISTAC

The primary role of the ISTAC within CERIC is to offer guidance to the General Assembly (GA) regarding scientific and technological matters that significantly influence the optimal use of CERIC as a cutting-edge RI. Specifically, ISTAC assesses proposals for potential new PFs and oversees the functioning of existing ones, making recommendations to the GA concerning acceptability and continuation in CERIC's open access service. The periodic evaluation of the Hungarian PF was held in May 2024, with a site visit by the members of the ISTAC and additional international experts at the Budapest Neutron Centre. The Polish PF SOLARIS was also reviewed by members of ISTAC in November 2024, also with a site visit to the synchrotron facility in Krakow.

Scientific Highlights

New insights on catalytic nanoparticle synthesis[2]

CATALYSIS | ENERGY

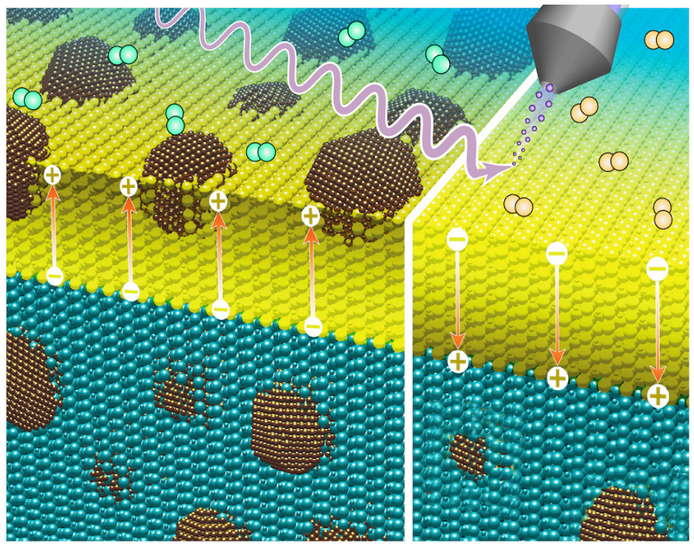
X-ray Photoelectron Spectroscopy

Moritz Weber

Felix Gunkel

Efficient catalysts can facilitate chemical reactions that split water molecules into hydrogen and oxygen and vice versa, i.e., the interconversion of hydrogen fuel and electric energy. Therefore, catalysts are essential for green hydrogen-based energy technologies using renewable power coming from solar or wind generators. Importantly, their performance is largely determined by their surface properties.

Within this context, **Dr. Moritz Weber, Dr. Felix Gunkel, Dr. Christian Lenser** and colleagues from the Forschungszentrum Jülich (FZJ) described the complex reactions that take place during metal exsolution - a solid-state reaction where metallic nanoparticles segregate from a functional oxide, allowing a tailored design of catalyst particles to be obtained on an atomic level. They explain the fundamental processes that occur during the formation of the nanoparticles and demonstrate that the kinetics of such reactions depends on the electrostatic interaction between the exsolution-active species and the electric field at the surface of the underlying functional oxide. To do so, FZJ researchers – supported by **Dr. Smid Bretislav**, Charles University of Prague - used near-ambient pressure X-ray photoelectron spectroscopy (NAP-XPS) available at the Czech CERIC Partner Facility.



"We have been able to fine control the nanoparticles fabrication in metal exsolution catalysts, but also to describe the fundamental reactions that occur during this process".

Figure 7
Controlled fabrication of nanoparticles through metal exsolution: the movement of metal oxide ions dispersed in a functional oxide is strongly influenced by an internal electric field (space charge region). The ions are chemically reduced at the surface and nucleate in the form of metallic nanoparticles. Copyright: Thomas Pössinger, RWTH Aachen / Moritz L. Weber, Forschungszentrum Jülich

These findings represent a significant improvement in the understanding and degree of control of nanoparticles in metal exsolution catalysts, particularly relevant for high-temperature fuel and electrolysis cells, and pave the way for the development of catalysts based on abundant metals, eliminating the need for expensive and hard to come by noble metals.

[2] *Space charge governs the kinetics of metal exsolution,* Weber M.L., Šmíd B., Breuer U., Rose M.-A., Menzler N.H., Dittmann R., Waser R., Guillon O., Gunkel F., Lenser C., Nature Materials, 2024, DOI: https://doi.org/10.1038/s41563-023-01743-6

Understanding metals interactions in electrolysers to produce green hydrogen[3]

ENERGY | HYDROGEN

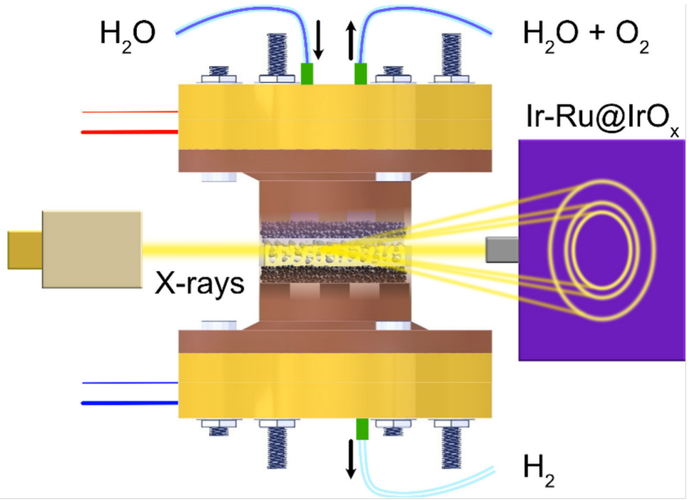
Electron Spectroscopy, Scanning Electron Microscopy

Tomáš Hrbek

Peter Kus

Hydrogen produced through water electrolysis is a promising CO_2 emissions-free alternative to fossil fuels. Proton Exchange Membrane Water Electrolysers (PEM-WE) are commonly used to achieve green hydrogen; however, to facilitate their market application, it is crucial to reduce the amount of expensive noble metals, such as iridium (Ir), used by these devices.

In this context, bimetallic Ir-metal catalysts, such as Ir-Ru or Ir-Ni, proved comparable or higher in activity compared to purely Ir-based ones, yet with much lower Ir loading. A possible explanation of this effect is that the crystallographic structure of catalysts affects their electronic structure and, ultimately, their catalytic activity. To test this hypothesis, **Dr. Tomáš Hrbek, Dr. Peter Kus** and colleagues of the Nanomaterials Group at the Charles University in Prague used different, complementary techniques available at the CERIC Czech Partner Facility: Electron Spectroscopy for Chemical Analysis under Environmental Conditions (EnviroESCA), High Resolution Field Emission Scanning Electron Microscopy (FESEM), and Synchrotron Radiation Photoelectron Spectroscopy (SRPES) available at the Materials Science Beamline in Elettra. They could then understand that, together, Ru and Ir dynamically form a core-shell structure. The IrOx shell, strained by the Ir-Ru core, maintains a lower oxidation state than the pure Ir catalyst, leading to superior catalytic activity and stability.



"Strain-engineered Ir shell boosts Oxygen Evolution Reaction activity and stability, enabling cost-effective, efficient green hydrogen production in Proton Exchange Membrane electrolysers".

Figure 8
The schematics of the operando investigation of the Ir-Ru catalyst using diffraction methods.

These findings not only clarify the performance-enhancing mechanisms of Ir-Ru catalysts but also pave the way for the application of other, more economical materials as effective cores in Ir-metal systems applied to PEM-WEs.

[3] *Strain-Engineered Ir Shell Enhances Activity and Stability of Ir-Ru Catalysts for Water Electrolysis: An Operando Wide-Angle X-Ray Scattering Study,* Hrbek T., Kus P., Drnec J., Mirolo M., Nedumkulam H., Martens I., Novakova J., Skala T., Matolinova I., Advanced Energy Materials, 2024, DOI: https://doi.org/10.1002/aenm.202403738

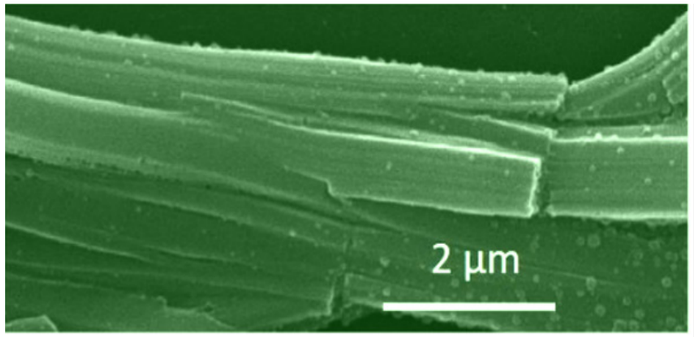
Deep litography, X-ray Scattering

Enhancing Chemical Stability in Porous Materials: from metal-organic frameworks to robust oriented polymers[4]

NANOTECHNOLOGIES | PHOTONICS

Due to their unique structural properties, metal-organic frameworks (MOFs) are promising materials for device fabrication in sensing, electronics, and photonics. However, the fabrication of organized macroscopic MOF 3D-oriented superstructures, such as films, is still challenging, due to the polycrystalline nature of MOFs and their relatively poor chemical and structural stability under environmental conditions (such as humidity).

To address this, **Dr. Lea Brandner, Prof. Paolo Falcaro**, colleagues at the Technical University of Graz (TU Graz), and international collaborators, used N_3-functionalised 3D-oriented MOF films as precursors to develop porous polymeric patterns with enhanced hydrolytic stability. During the micropatterning protocol, fundamental for the realisation of microdevices, scientists used deep X-ray lithography available at the Austrian CERIC Partner Facility of the Technical University Graz (at Elettra). Moreover, to evaluate potential structural changes associated with exposure to environmental conditions (such as structural changes in acidity or humid conditions), researchers performed small-angle X-ray scattering (SAXS) analyses, using the beamline available at the same Partner Facility.



Interestingly, the developed polymer showed a high chemical stability, as well as anisotropic fluorescent response. The use of 3D-oriented MOF systems as precursors could then be considered an efficient strategy to prepare oriented porous polymers, which will advance optical components and microdevices for photonic applications.


Lea Brandner


Paolo Falcaro

Figure 9
Scanning electron microscope image of oriented polymer particles replicating the shape of the template MOF Crystals

"We successfully developed and described porous polymers that show high stability, using as precursors 3D-oriented metal-organic frameworks films".

[4]*Ordered Transfer from 3D-Oriented MOF Superstructures to Polymeric Films: Microfabrication, Enhanced Chemical Stability, and Anisotropic Fluorescent Patterns,* Brandner L.A., Marmiroli B., Linares-Moreau M., Barella M., Abbasgholi-NA B., Velásquez-Hernández M.D.J., Flint K.L., Dal Zilio S., Acuna G.P., Wolinski H., Amenitsch H., Doonan C.J., Falcaro P., Advanced Materials, 2024, DOI: https://doi.org/10.1002/adma.202404384

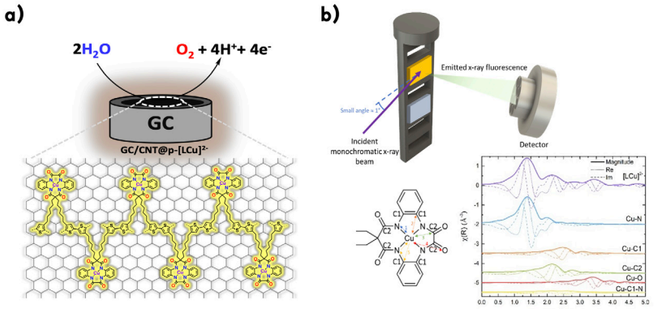
X-ray absorption spectroscopy

New-generation anodes for water oxidation[5]

ENERGY | HYDROGEN

Water splitting is a crucial process for producing clean hydrogen fuel, a potential alternative to fossil fuels. This reaction involves two key steps: water oxidation to generate oxygen and proton reduction to produce hydrogen. Developing efficient, stable, and low-cost catalysts for water oxidation is essential for making hydrogen production sustainable. While noble metals like ruthenium and iridium are highly effective, they are scarce and expensive.

Within this framework, the Nanomaterials for Energy Conversion and Storage group (N-REX) from the Department of Physics and Astronomy at the University of Bologna and the Institute of Chemical Research of Catalonia (ICIQ) collaborated to develop a cost-effective, earth-abundant molecular catalyst. This newly designed copper-based complex was engineered to anchor onto conductive or semiconductive surfaces by incorporating a thiophene group into the macrocyclic ligand backbone, preserving the metal centre's intrinsic electronic properties.



The catalyst demonstrated efficient water oxidation at neutral pH, maintaining strong performance for over 24 hours. X-ray Absorption Spectroscopy (XAS) was instrumental in confirming its molecular structure, oxidation state, and long-term stability. Conducted at the LISA beamline—a CERIC Associated Facility at the European Synchrotron Radiation Facility in Grenoble, France—XAS analysis revealed that, unlike many first-row metal catalysts that degrade into oxides, this Cu-based catalyst retains its structural integrity, positioning it as a promising candidate for sustainable water electrolysis.

Developed within the Horizon 2020 project CONDOR, this study presents a cost-effective copper-based catalyst for water oxidation. XAS served as a powerful tool to verify its structural integrity, which underpins its long-term stability and efficiency.

[5]*Robust Molecular Anodes for Electrocatalytic Water Oxidation Based on Electropolymerized Molecular Cu Complexes,* Amthor S., Ranu K., Bellido C.G., Salomón F.F., Piccioni A., Mazzaro R., Boscherini F., Pasquini L., Gil-Sepulcre M., Llobet A., Advanced Materials, 2024, DOI: https://doi.org/10.1002/adma.202308392


Raffaello Mazzaro

Figure 10
a) A visual depiction of the molecular catalyst-engineered glassy carbon (GC) anode used for water oxidation.
b) A schematic of the experimental setup for acquiring EXAFS spectra, with the lower section showing the experimental Fourier transform of the k^2-weighted EXAFS spectrum for the pristine Cu-based catalyst, highlightsiing the contributions of the scattering paths used in the fitting process, with colors corresponding to those in the molecular drawing.


Alberto Piccioni

"We developed a cost-effective copper-based catalyst for water oxidation. XAS served as a powerful tool to verify its structural integrity, which underpins its long-term stability and efficiency".

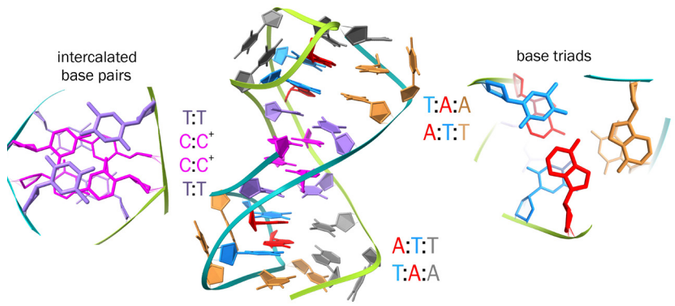
NMR spectroscopy

NMR analyses shed light on non-canonical 3D DNA structures[6]

BIOLOGY | GENOME

It is well known that, in addition to the famous double helix structure described by Watson and Crick in 1953, certain genomic segments can adopt a variety of peculiar 3D structures. Formation of such non-canonical architectures appears more frequent in regions comprising tandem repeats and is promoted by particular internal or environmental stimuli.

Dr. Marko Trajkovski (Slovenian NMR Centre, National Institute of Chemistry), **Prof. Annalisa Pastore** (King's College London), and Prof. Janez Plavec (Slovenian NMR Centre) analysed and characterised DNA oligonucleotides comprising repeats of five nucleotides, ATTTC, that are present in hundreds of genes which play crucial roles in several physiological cellular processes, such as transcriptional regulation, intracellular signalling, protein and membrane trafficking and cell adhesion. At the same time, the insertion and expansion of this pentanucleotide is observed in non-coding genomic regions associated with a number of neurological disorders (including some subtypes of ataxia and epilepsy).
Exploiting advanced Nuclear Magnetic Resonance instruments available at the Slovenian CERIC Partner Facility in Ljubljana, such as DAVID and ASKA spectrometers, scientists showed that, in a solution containing divalent cations, such as Mg^{2+} and Ca^{2+}, DNA comprising ATTTC repeats folds into a novel architecture: in this 3D structure, the central part corresponds to a block of four intercalated C:C+ and T:T base pairs, and is extended on each side by segments stabilised by pairs of base triads.



These results could enhance the understanding of the physiological and pathological roles of non-canonical 3D structures, helping to describe how these processes are regulated in living cells.


Mark Trajkovski

"Solution-state NMR reveals formation of dimeric pentanucleotide structure in the presence of Mg^{2+} ions, highlighting unexplored potential of divalent cations in driving DNA folding and functions."


Annalisa Pastore

Figure 11
Dimeric d(ATTTC)3 structure formed in the presence of Mg2+ ions


Janez Plavec

[6] *Dimeric structures of DNA ATTTC repeats promoted by divalent cations,* Trajkovski M., Pastore A., Plavec J., Nucleic Acids Research, 2024, DOI: https://doi.org/10.1093/nar/gkae052

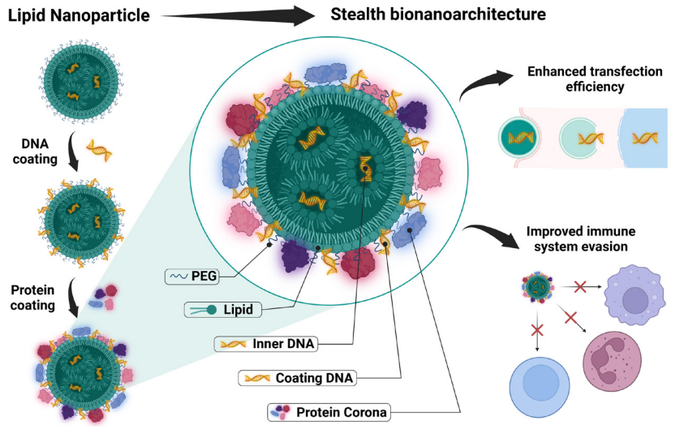
X-ray Scattering

Fighting cancer and genetic diseases with lipid nanoparticles[7]

BIOTECHNOLOGY | HEALTH

The rise of lipid nanoparticles has revolutionised the field of gene therapy. Also used in the development of messenger RNA (mRNA)-based vaccines against COVID-19, lipid nanoparticles have shown great success in several clinical applications.

Prof. Giulio Caracciolo and **Prof. Daniela Pozzi** (Sapienza University's NanoDelivery Lab, Rome), in collaboration with other Italian and European institutes (such as the Pasteur Institute in Italy, the Scuola Normale Superiore in Pisa and the Technical University of Graz in Austria) studied the ability of these particles to effectively encapsulate large DNA molecules. The designed technology uses lipid nanoparticles capable of incorporating large DNA. The resulting particles are then further engineered and coated with a biomolecular crown made of DNA and plasma proteins: following this modification, the resulting lipid nanoparticles become a true biological nano-architecture capable of evading the immune system and increasing the effectiveness of gene therapy.



The innovative approach of this research demonstrates an improved DNA transport capacity compared to classical formulations, while ensuring greater stability and reduced immune response. This could enable the correction of genetic defects and provide tools for the fight against cancer, representing an important step towards innovative therapies for diseases that are difficult to treat with the methods currently used in clinical practice.
'These particles have a unique morphology and demonstrate an improved transport capacity compared to traditional formulations, opening the way to new targeted gene therapies.

[7] *Structuring lipid nanoparticles, DNA, and protein corona into stealth bionanoarchitectures for in vivo gene delivery,* Renzi, S., Digiacomo, L., Pozzi, D. et al., Nature Communications, 2024, DOI: https://doi.org/10.1038/s41467-024-53569-8


Giulio Caracciolo

"The developed lipid nanoparticles have a unique morphology and demonstrate an improved transport capacity compared to traditional formulations, opening the way to new targeted gene therapies".

Figure 12
The lipid nanoparticles, after incorporating DNA, are engineered and coated with an outer layer, which allows to evade the immune system. Credits: NanoDelivery Lab


Daniela Pozzi

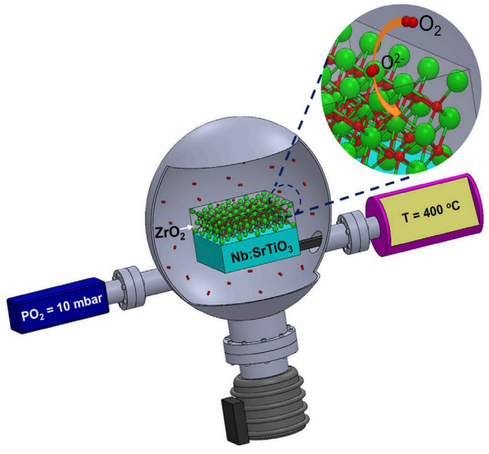
Transmission electron microscopy, X-ray Photoelectron Spectroscopy

The role of oxygen vacancies in ferroelectric zirconia thin films[8]

MATERIALS SCIENCES

In the last few years, defect engineering provided a powerful tool for tailoring nanomaterials for several applications, and to switch from nanoscale to atomic-scale electronics. Among nanomaterials that have been modified with this approach are ferroelectric oxide thin films, structures that are compatible with the present semiconductor technologies, provide robust ferroelectric polarization and have been then used for ferroelectric memory and field-effect transistors, energy storage devices and sensors.

To obtain a robust ferroelectric polarization, several polycrystalline thin films require an initial wake-up pre-cycling. Epitaxial thin films seem to be an exception; however, spontaneous polarization observed in these structures is not fully understood. **Dr. José P. B. Silva, Dr. Veniero Lenzi, Prof. Luís Marques** from the University of Minho, the University of Cambridge, together with Czech and Romanian CERIC Partners exploited X-ray Photoelectron Spectroscopy (XPS) and High-Resolution Transmission Electron Microscopy (HRTEM) instruments, available respectively at the Czech and Romanian CERIC Partner Facilities, to study this mechanism in ZrO_2 thin films.



They then demonstrated through density functional theory simulations and by investigating the structural properties, chemical composition and ferroelectric properties of the films before and after an annealing at moderate temperature (400 °C) in an oxygen-rich environment, that oxygen vacancies are a key factor for stabilizing the polar rhombohedral phase and a possible source of ferroelectric polarization.

José P. B. Silva

Veniero Lenzi

Figure 13
Schematic representation of the annealing process. Green and red spheres represent Zr and O atoms, respectively.

"Density functional calculations reveal that charged oxygen vacancies help to stabilise the rhombohedral phase over all other zirconia phases and provide an explanation for its spontaneous polarization".

Luís Marques

[8] *Ferroelectricity induced by oxygen vacancies in rhombohedral ZrO2 thin films,* Lenzi V., Silva J.P.B., Šmíd B., Matolín V., Istrate C.M., Ghica C., MacManus-Driscoll J.L., Marques L., Energy & Environmental Materials, 2024, DOI: https://doi.org/10.1002/eem2.12500

NMR spectroscopy, Inelastic Ultraviolet Scattering, Scattering diffraction

Enhancing the stability of DNA: a new era for nucleic acid preservation[9]

BIOLOBY | GENOMICS

Preserving the structural integrity of DNA is crucial in many fields of biology and biotechnology. However, the stability of nucleic acids in aqueous solutions is easily compromised by factors like temperature fluctuations, pH changes, and ionic strength variations. Deep eutectic solvents (DESs), particularly the ones based on choline chloride, are a promising alternative to enhance the stability of nucleic acids, avoiding - due to their low volatility, high stability, tuneable chemical characteristics, and low toxicity – the unwanted effects related to traditional preserving methods.

Dr. Barbara Rossi (Elettra) and **Prof. Andrea Mele** (Politecnico of Milano) and colleagues applied a multi-technique approach to better understand how three different choline-based DESs interact with nucleic acid, in particular with 30-base pair double-stranded DNA structure in aqueous solutions. To do so, probing base stacking, hydrogen bonding, and electrostatic interactions that occur, researchers exploited Inelastic Ultraviolet Scattering available at the CERIC Italian Partner Facility, coupled with molecular dynamics simulations. Scientists could then demonstrate that the establishment of hydrogen bonds between choline ions and DNA, particularly at A-T base pairs, is a key factor in maintaining the DNA structure. Moreover, these experiments suggest that DESs actively participate in stabilizing the base stacking, and that electrostatic interactions are critical to preserve DNA's helical structure. With the growing understanding of how DESs interact with nucleic acids at the molecular level, it could be possible to develop a new generation of solvent systems that could revolutionize the way we handle and store nucleic acids in both research and industrial applications.

Barbara Rossi

"This study opens the way for a systematic investigation of the properties of DES as co-solvents able to improve the thermal stabilization of double-stranded canonical DNA structure".

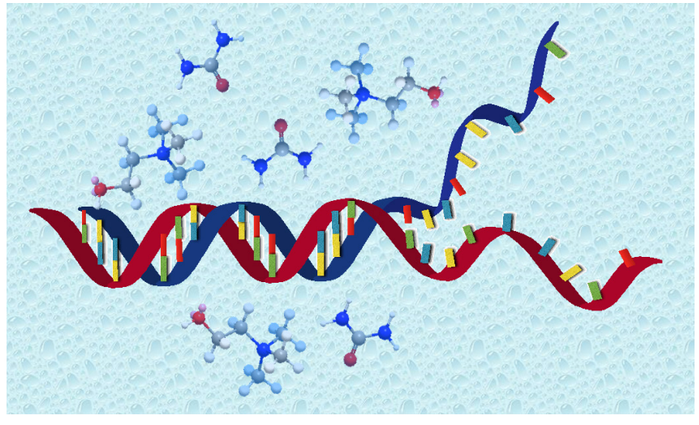


Figure 14
The thermal stability of double-stranded DNA is significantly improved by choline-based DES thanks to the interaction between hydrogen-bonding sites of guanine residues and DES and and the hydration shell perturbation of AT pairs

Andrea Mele

[9] *Local and cooperative structural transitions of double-stranded DNA in choline-based deep eutectic solvents,* Fadaei F., Tortora M., Gessini A., Masciovecchio C., Vigna J., Mancini I., Mele A., Vacek J., Minofar B., Rossi B., International Journal of Biological Macromolecules, 2024, DOI: https://doi.org/10.1016/j.ijbiomac.2023.128443

Transmission electron microscopy, X-ray absorption spectroscopy

Redefining glioblastoma treatment: the role of copper in targeted anticancer therapies[10]

BIOLOGY | HEALTH

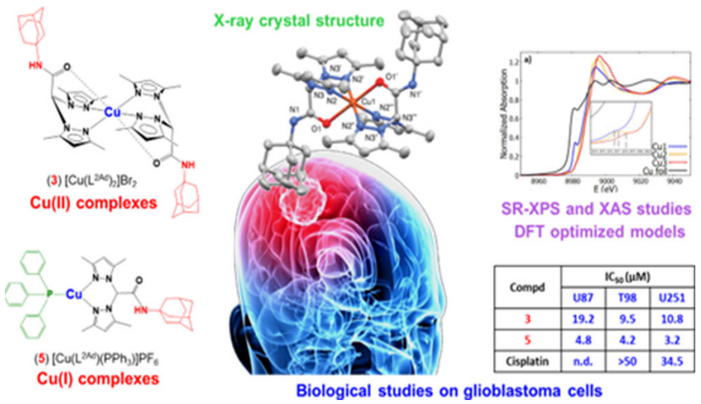
Many chemotherapy options currently available come with serious side effects, such as damage to healthy cells, and the risk of cancer cells becoming resistant. A more efficient and targeted option, especially for solid tumours such as glioblastoma (GBM), can come from copper complexes: they cause DNA damage, generate reactive oxygen species, inhibit proteasomes, and they enhance the effectiveness of temozolomide (TMZ), the standard treatment for these tumours.

Prof. Chiara Battocchio, Dr. Simone Amatori (Roma Tre University) and colleagues have synthesized and characterised novel copper complexes, based on the coupling between bifunctional species L2H and the drug amantadine (which has recently shown antiproliferative effects in different human tumour cell lines). Researchers could describe in detail the structure of these complexes exploiting a combination of Near Edge X-ray Absorption Fine structure (NEXAFS), X-ray Photoelectron Spectroscopy (XPS) and XAS, available respectively at the Italian CERIC Partner Facility at Elettra and at the CNR's LISA Beamline (CERIC Associated Facility at the European Synchrotron Radiation Facility). Furthermore, they tested on three different GBM cell lines the antitumoral efficiency of the new copper complexes, and their ability to enhance the chemosensitivity to TMZ.
Scientists could then prove that copper complexes affect cell growth,

Chiara Battocchio

"Copper complexes were synthetized and characterised to understand their structure. Their application as antitumoral agents was evaluated on various kinds of glioblastoma solid cancer cell lines".

Simone Amatori



Compd	IC_{50} (μM)		
	U87	T98	U251
3	19.2	9.5	10.8
5	4.8	4.2	3.2
Cisplatin	n.d.	>50	34.5

Figure 15
Structure of Cu complexes 1,2,4 and 5 (left), crystallographic structure of Cu complex 3 (center). Structural (XAS) and cell viability (IC50) characterizations (right).

proliferation, and death due to increased production of reactive oxygen species and DNA damage, Interestingly, nontoxic doses of these compounds enhanced the chemosensitivity to TMZ.

[10] *Copper-Based Complexes with Adamantane Ring-Conjugated bis(3,5-Dimethyl-pyrazol-1-yl) acetate Ligand as Promising Agents for the Treatment of Glioblastoma,* Morelli M.B., Caviglia M., Santini C., Del Gobbo J., Zeppa L., Del Bello F., Giorgioni G., Piergentili A., Quaglia W., Battocchio C., Bertelà F., Amatori S., Meneghini C., Iucci G., Venditti I., Dolmella A., Di Palma M., Pellei M., J. Med. Chem., 2024, DOI: https://doi.org/10.1021/acs.jmedchem.4c00821

Ion beam

How to use high-energy ion irradiation to create nanoporous graphene[11]

GRAPHENE | NANOTECHNOLOGIES

Graphene has remarkable physical and chemical properties, and one of its most exciting potentials lies in the development of nanoporous graphene—graphene embedded with tiny, nanometer-sized pores, which can be engineered for a variety of applications. A way to create a controlled distribution of nanopores in graphene is through high-energy ion beam irradiation (with energies ranging from 1–10 MeV), even if at these energies only tiny nanopores are predicted to form.

The study of defect formation and nanopore morphology at these higher energies is crucial for controlling the size, distribution, and number of defects in graphene, which affects their properties, and functionality. That's why **Dr. Kristina Tomić Luketić**, **Dr. Andreja Gajović** and **Dr. Marko Karlušić** (Ruđer Bošković Institute, in Zagreb) used Raman Spectroscopy to study the changes in morphology of single-layered supported graphene sheets irradiated by iodine, copper, silicon, and oxygen ions in the MeV energy range at the ToF-ERDA instrument, available at the CERIC Croatian Partner Facility.

Interestingly, an inverse correlation was observed: as ion velocity increases, the size of the nanopores decreases. Additionally, scientists discovered that damage accumulation is heavily influenced by electronic stopping (that happens when ions deposit their energy in the electronic subsystem of the target): in cases where it dominates over nuclear stopping (in which energy deposition occur through elastic collisions with the target nuclei) by two orders of magnitude, graphene experiences substantial defect formation.

Kristina Tomić Luketić

Andreja Gajović

"High-energy heavy ion irradiation is presented as a powerful tool for tailoring nanoporous graphene structures, enabling their use for various nanofiltration applications".

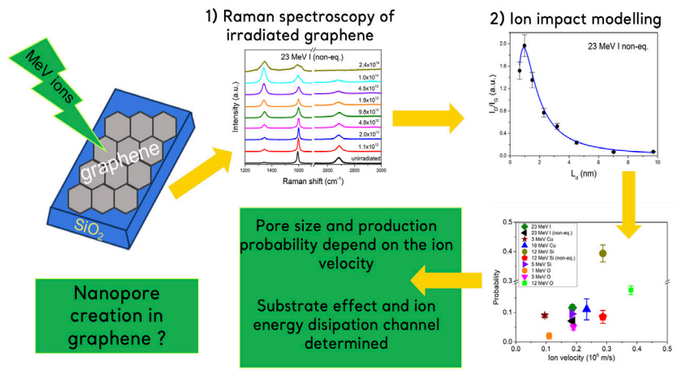


Figure 16
Schematic representation of the analysis performed.

The findings coming from this systematic investigation enable custom-made production of nanoporous graphene using high-energy heavy ion beam for a variety of applications, including the development of nanomembranes for gas separation, sensors, or even separators Li-ion batteries and supercapacitors.

[11] *High-energy heavy ions as a tool for production of nanoporous graphene,* Tomić Luketić K., Gajović A., Karlušić M., Applied Surface Science, 2024, DOI: https://doi.org/10.1016/j.apsusc.2024.160593

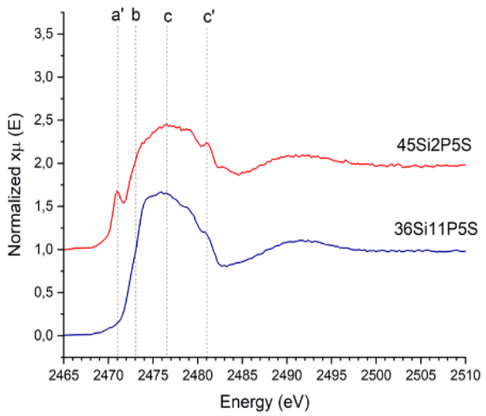
X-ray absorption spectroscopy

The role of sulfur into glass formation[12]

CHEMISTRY | MATERIALS SCIENCE

Sulfur, a widespread element is characteristically heterovalent, exhibiting a great range in oxidation state (-2 to +6) and forms chemical bonds with both more electropositive and more electronegative elements. Under reducing conditions, sulfur behaves as an anion, forming bonds directly with metal cations, whereas under oxidizing conditions, it is a complex forming cation, and in some compounds of intermediate oxidation state, it occurs in both anionic and cationic forms. The degree of oxidation of sulfur has a significant effect on the process of melting, forming, clarification, glass structure and properties of the final product, i.e., viscosity, mechanical properties and optical properties (light transmittance and colour). The solubility of sulfur in the structure of phosphate glass is higher than that in silicate or borosilicate glass.

Under reducing conditions, sulfur can incorporate into glass matrices, significantly influencing the polymerisation of the glass network and altering their structures, properties and functionality. **Dr. Justyna Sułowska** (AGH University of Krakow, Poland) and colleagues, including **Dr. imone Pollastri** (Elettra, Italy) and **Dr. Joanna Stępień** (AGH University of Krakow, Poland) whose effort has been particularly important for this work, applied a variety of spectroscopic techniques, including X-ray Absorption Fine Structure (XAFS) and X-ray Absorption Spectroscopy (XAS), available at CERIC Italian and Polish Partner Facilities, respectively, to identify sulfur's bonding environment (i.e., whether it is in the form of a sulfate (S^{6+}) or sulfide (S^{2-})), and understand its behavior in glass matrices. Scientists found that the addition of sulfur increased the ability of glasses with higher amounts of phosphorous oxide to form. Furthermore, XAFS spectra demonstrated that S-bearing glasses contain sulfur in the reduced form as S^{2-}. This finding is shown in the accompanying Figure for glasses containing 45 mol.% SiO_2 and 2 mol.% P_2O_5 (45Si2P5S sample) and 36 mol.% SiO_2 and 11 mol.% P_2O_5 (36Si11P5S sample).



These findings significantly enhance the understanding of sulfur's structural role in glassy materials, offering insights into how these materials can be optimised for industrial and agricultural uses and paving the way for sustainable applications in material science and beyond. On the basis of spectroscopic studies, it can be also concluded that sulfur ions can scavenge charge-balancing modifier cations from the silicate and phosphate subnetworks.


Justyna Sułowska


Simone Pollastri

"A progressive process of greening caused sulfur deficiency in several areas worldwide: in the future, such silicate-phosphate glasses could then be used as soil fertilizers".

Figure 17
Normalised XANES spectra at the S K-edge of investigated samples. Reference lines "a'" to "c'" correspond to the following energy positions: a') 2471.0 eV; b) 2472.8 eV; c) 2476.7 eV; c') 2481.0 eV

This work was financed by the National Science Centre, Poland, project number 2018/31/D/ST8/03148 entitled "Chemically active glasses as potential sulphur carriers for the soil environment" (Recipient: Justyna Sułowska).

[12] *Influence of sulfur ions on the glass-forming ability and structure of silicate-phosphate glasses*, Sułowska J., Szumera M., Berezicka A., Olejniczak Z., Stępień J., Pollastri S., Olivi L., Journal of Alloys and Compounds, 2024, DOI: https://doi.org/10.1016/j.jallcom.2023.172995

X-ray absorption spectroscopy

Exploring the potential biomedical applications of magnetite nanoparticles[13]

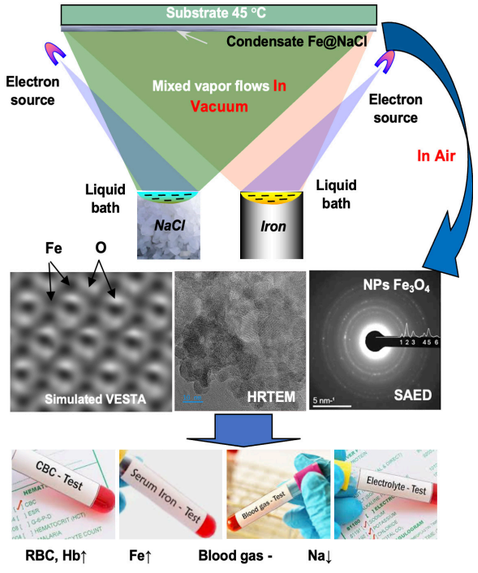
HEALTH, NANOTECHNOLOGIES

Nanoparticles (NPs) made from metals and their oxides, particularly magnetite (Fe_3O_4), have garnered significant attention due to their superparamagnetic properties, biocompatibility, and potential role in metabolic processes. The pharmacokinetics of magnetite NPs is influenced by their size and coating. Rapid distribution and elimination of uncoated magnetite NPs makes them useful in emergency conditions, such as post-haemorrhagic syndrome.

While natural magnetite NPs are found in biological systems, artificial magnetite ones are produced through various methods, in particular electron beam technology in vacuum. Using different techniques, including, Holographic Transmission Electron Microscopy available at the CERIC Associated Facility at the University of Salento, **Dr. Stanislav Lytvyn** (E. O. Paton Electric Welding Institute, Ukraine) and colleagues investigated the effects of pure (i.e. ligand-free) magnetite NPs, synthesized via electron beam physical vapor deposition.

Prof. Lucio Calcagnile's team (University of Salento, Italy) performed HRTEM, SAED and FFT analyses, combined with the VESTA crystal model, and confirmed the absolute purity of the synthesized Fe_3O_4 NPs and their ideal surface and internal lattice structure, including the precise arrangement of iron and oxygen atoms in magnetite. The administration of these NPs in the sodium chloride matrix to intact animals by **Prof. Elena Vazhnichaya** (Poltava State Medical University, Ukraine) revealed a transient increase in the main indicators of red blood. It did not worsen blood gases and pH, decreased blood Na+ and caused changes in the parameters of serum iron. More intense rapid effects on haematological parameters at lower serum iron indicated greater activity of the studied magnetite NPs compared to the reference iron preparation.

These insights about pure magnetite NPs structure and action could then be used to derive applications in a variety of fields, including anti-anaemic treatment.




Lucio Calcagnile

"These nanoparticles can be used to transport physically bound oxygen and correct haematological parameters in acute blood loss; they can be conjugated with antioxidants or antibiotics to acquire new activity".


Stanislav Lytvyn

Figure 18
Production of magnetite NPs, TEM analysis and haematological testing.

[13] *Effect of pure (ligand-free) nanoparticles of magnetite in sodium chloride matrix on hematological indicators, blood gases, electrolytes and serum iron,* Lytvyn S.Y., Vazhnichaya E.M., Manno D.E., Kurapov Y.A., Calcagnile L., Rinaldi R., Carbone G.G., Semaka O.V., Nedostup Y.V., Micro and Nano Systems Letters, 2024, DOI: https://doi.org/10.1186/s40486-024-00209-x

Infrared spectroscopy

Discovered the use of psychotropic substances in ancient Egypt[14]

CULTURAL HERITAGE

State-of-the-art analytical techniques available nowadays make it possible to uncover details invisible to the naked eye in archaeological artefacts, revealing practices from the past, such as the ritual use of psychotropic substances in ancient Ptolemaic Egypt.

Using a multi-disciplinary approach, **Dr. Enrico Greco** (University of Trieste), CERIC researcher **Dr. Chiaramaria Stani** and colleagues from the University of South Florida, the University of Milan and Elettra analysed the content of a ritual vase, dating back over 2,000 years. To do so, they applied several different techniques, including using Fourier Transform Infrared (IR) micro-spectroscopy coupled to Synchrotron Radiation (SR μ-FTIR) available at the CERIC Italian Partner Facility.

Enrico Greco

Chiaramaria Stani

These measurements gave first indications of the use of psychotropic substances of plant origin, such as Peganum harmala (Syrian rue). Thanks to the combination of other complementary advanced bio-scientific methods (proteomics, metabolomics, and metabarcoding of plant DNA), it has been possible to comprehensively identify the ceremonial content of the vase: in the mixture analysed, scientists detected traces of different plants known for their psychotropic or medicinal properties, as well as fermented liquids, honey or royal jelly and human fluids, such as blood and mucous membrane proteins.

All these information suggests that the jar was used in symbolic and transformative rituals, probably related to female fertility, thus opening a window on hitherto unexplored cultural procedures from the ancient past.

"By combining advanced non-invasive techniques with cultural, linguistic and historical analysis, we obtained information that traditional archaeology alone could not have provided".

Figure 19
Drinking vessel in shape of Bes head; El-Fayūm Oasis, Egypt; Ptolemaic-Roman period (4th century BCE – 3rd century CE), (courtesy of the Tampa Museum of Art, Florida).

[14] *Multianalytical investigation reveals psychotropic substances in a ptolemaic Egyptian vase* D. Tanasi, B.F. van Oppen de Ruiter, F. Florian, R. Pavlovic, L.M. Chiesa, I. Fochi, C. Stani, L. Vaccari, D. Chaput, G. Samorini, A. Pallavicini, S. Semeraro, A.S. Gaetano, S. Licen, P. Barbieri, E. Greco, Scientific Reports, 2024, DOI: https://doi.org/10.1038/s41598-024-78721-8

Scanning Electron Microscopy, NMR spectroscopy, Scattering diffraction

Shaping the future of bone regeneration: aerogels and hybrid materials[15]

HEALTH | MATERIALS SCIENCES

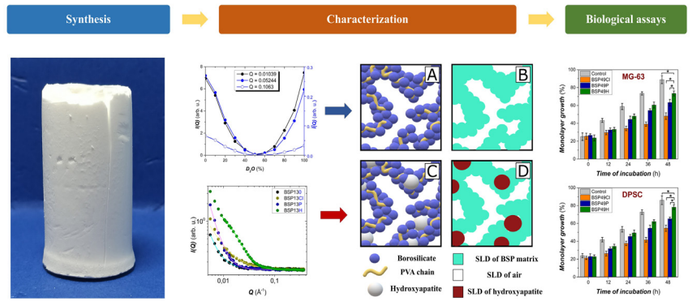
Autografts are still the go-to solution to treat bone damage, even if they come with significant drawbacks, including complications from additional surgeries and donor site morbidity. Promising alternatives include synthetic, biocompatible materials that can mimic the bone natural structure. In particular, aerogels are ultra-light, highly porous materials, whose structure can be fine-tuned, even combining with synthetic polymers, such as polyvinyl alcohol (PVA), a material already used in other biomedical applications and known to enhance the bioactivity of bone scaffolds when integrated with borosilicate glasses.

Zoltán Balogh

Dr. Zoltán Balogh, Dr. Zoltán Dudás, Dr. József Kalmár and colleagues of the University of Debrecen and the Budapest Neutron Centre developed borosilicate gels hybridised with PVA of different molecular weights. Moreover, incorporating various calcium sources and hydroxyapatite, they developed nanostructured, open-porous aerogels that could improve bone tissue regeneration.

Zoltán Dudás

The hybridised aerogels have been fully characterised, in terms of both nanostructure and chemical composition, using different analytical instruments, including the solid state Nuclear Magnetic Resonance Spectrometer and the Small Angle Neutron Scattering Diffractometer available at the CERIC Slovenian and Hungarian Partner Facility, respectively. Then, researchers tested the viability and proliferation of osteosarcoma cells and mesenchymal stem cells in the presence of these aerogel particles using time-lapse video microscopy.



The results showed that the newly developed PVA hybridised aerogels provide a promising environment for bone-forming cells, promoting both cell attachment and growth, and that they can then be good candidates for bone regeneration applications.

"Thanks to a multi-technique approach, we studied in detail the chemical and morphological properties, as well as the bioactivity, of novel nanostructured hybrid borosilicate–PVA aerogels with potential for bone regeneration".

Figure 20
Nanoscale structural and in vitro biological investigation of newly synthesized borosilicate - PVA hybrid aerogels.

József Kalmár

[15] *Nanoscale Structural Characteristics and In Vitro Bioactivity of Borosilicate-Poly(vinyl alcohol) (PVA) Hybrid Aerogels for Bone Regeneration,* Balogh Z., Len A., Baksa V., Krajnc A., Herman P., Szemán-Nagy G., Czigány Z., Fábián I., Kalmár J., Dudás Z., ACS Applied Nano Materials, 2024, DOI: https://doi.org/10.1021/acsanm.3c05668

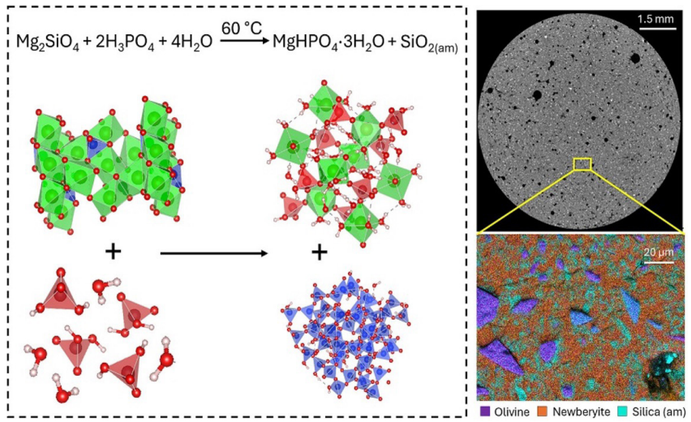
X-ray absorption spectroscopy

Exploring olivine-based cements for sustainable construction[16]

MATERIALS SCIENCES

The production of traditional Portland cement is responsible for a significant share of global carbon emissions. An alternative could be found in acid-base cements, specifically phosphate-based binders, such as magnesium phosphate cements (MPCs), which show impressive mechanical properties and durability. However, the high energy needed to produce raw materials, such as magnesium oxide, limits their use. A potential solution to this problem lies in the use of a naturally abundant mineral: olivine.

The reaction between olivine and phosphoric acid is central to the development of these alternative cements. To evaluate the materials structure at the micro and molecular level, and to better understand the underlying reaction mechanisms, **Dr. Davide Bernasconi** (University of Torino), **Dr. Alexey Maximenko** (National Synchrotron Radiation Centre SOLARIS) and colleagues used several complementary techniques, such as Phosphorus X-ray Absorption Spectroscopy available at the CERIC Polish Partner Facility. Scientists demonstrated that the cement formation process is influenced by factors such as the acid concentration, the liquid-to-solid mass ratio, and the water content in the raw mix. Moreover, up to 57% of olivine reactivity, whose dissolution was promoted by the curing temperature of 60 °C and low pH, has been achieved. This allowed the development of a dense matrix that reached 75 Mpa of compressive strength.



The development of olivine-based MPCs represents a significant step toward greener construction materials, and ongoing research will help refine these methods to ensure they can be implemented on a larger scale.

"Mg-rich olivine reacts with phosphoric acid to form dense phosphate cements with high mechanical strength, offering a sustainable alternative to MgO-based binders for eco-friendly construction".

Figure 21
Scheme of the cement setting reaction (left); 2D computed tomography slice of a cement cilinder (top right); SEM-EDS phase mapping (bottom right).

[16] *Setting reaction of a olivine-based Mg-phosphate cement*, Bernasconi D., Viani A., Zárybnická L., Bordignon S., Godinho J.R.A., Maximenko A., Celikutku C., Jafri S.F., Borfecchia E., Wehrung Q., Gobetto R., Pavese A., Cement and Concrete Research, 2024, DOI: https://doi.org/10.1016/j.cemconres.2024.107694

CERIC internal research - Scientific highlights

A multi-modal analysis to characterise fibrotic tissues[17]

BIOTECHNOLOGY | HEALTH

Absorption radiology and tomography

Lorenzo D'Amico

"Multi-technique characterisation of tissues could provide deeper insights into poorly understood pathologies, paving the way for improved diagnosis and treatments".

Pulmonary fibrosis (PF) is a disabling disease characterised by progressive involution of the lungs, that currently has no available curative approaches. Most cases of PF are of the idiopathic type, a heterogeneous group comprising disorders with very different pathophysiology: it is then essential to improve tissue characterisation techniques so that each type of fibrosis can be addressed in the most appropriate way.

Our PhD fellow **Lorenzo D'Amico**, together with colleagues from University Medical Center Göttingen, Max Planck Institute for Multidisciplinary Sciences and Georg-August-Universität Göttingen Institute for X-Ray Physics, developed and applied a novel multi-technique characterisation approach to tissues coming from two different preclinical mouse models, in which PF was induced either chemically (by Bleomycin) or by genetic modification.

Tissue analysis was then based on the combination of three different techniques: classical histopathology, propagation-based phase-contrast micro computed tomography (PBI-microCT, available at the SYRMEP beamline of the CERIC Italian Partner Facility in Elettra), and atomic force microscopy (AFM).

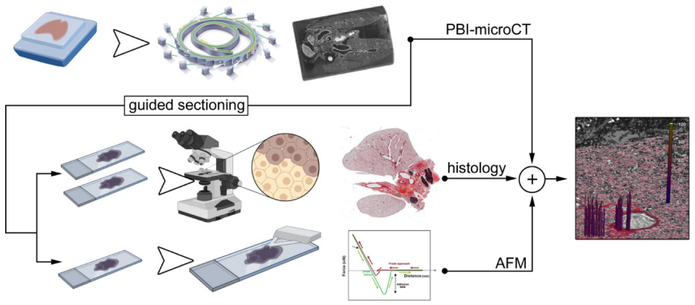


Figure 22
Graphic description of the research work and of the complementary analyses performed.

Researchers were then able to discriminate samples from the Bleomycin-induced model from those of genetically altered mice, thus distinguishing the different pathophysiology leading to PF.

This new pipeline of investigation could represent a new approach to the analysis of tissue samples, since Formalin Fixed Paraffin Embedded (FFPE) tissues are the most common way used worldwide in the hospitals to preserve vast and valuable patient material.

[17] *Characterization of transient and progressive pulmonary fibrosis by spatially correlated phase contrast microCT, classical histopathology and atomic force microscopy,* D'Amico L., Svetlove A., Longo E., Meyer R., Senigagliesi B., Saccomano G., Nolte P., Wagner W.L., Wielpütz M.O., Leitz D.H.W., Duerr J., Mall M.A., Casalis L., Köster S., Alves F., Tromba G., Dullin C., Computers in Biology and Medicine, 2024, DOI: https://doi.org/10.1016/j.compbiomed.2024.107947

Describing sodium structures and dynamics for the anode of Na-ion batteries[18]

BATTERIES | ENERGY

NMR spectroscopy

Matej Gabrijelčič

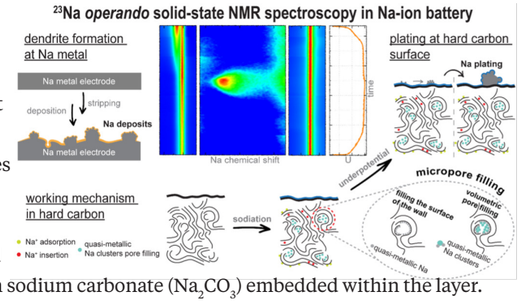
Alen Vižintin

"We provided an in-depth analysis of the formation and composition of solid electrolyte interphase, understood and differentiated the sodium storage processes, and distinguished between Na plating and dendrite growth".

Sodium-ion batteries are a safer, more ecological and efficient alternative to conventional, lithium-based ones. To improve their performance stability and solid electrolyte interphase formation, it is important to choose the right anode material. Hard carbons (i.e., non-graphitizable carbons) are promising candidates. It is important to characterise sodium storage with regard to both the structures and dynamics of such materials.

This has been the research focus of CERIC PhD researcher **Matej Gabrijelčič**, who - together with supervisor **Alen Vižintin** and colleagues of the Slovenian NMR (Nuclear Magnetic Resonance) Centre, and in collaboration with the Institute Jožef Stefan and University of Nova Gorica - used different, complementary techniques to describe anodes' structure and dynamics. These include X-ray Raman spectroscopy (XRS), exploited to study the structural changes of hard carbon anodes induced by different carbonisation temperatures and insertion of Na^+ ions during sodiation. With this technique, researchers found that higher carbonisation temperatures increase graphite-like order, while sodiation disrupts this order due to inserted Na^+ ions, and that systematic variations in the solid electrolyte interface (SEI) composition occur during cycling.

Furthermore, the research team used *operando*, *in situ* and *ex situ* solid-state spectroscopy techniques available at the CERIC Slovenian Partner Facility at the National Institute of Chemistry in Ljubljana. Using 600MHz MAGIC and 400MHz NIKA NMR spectrometers, scientists found out that at higher temperatures, larger pores facilitate the formation of quasi-metallic sodium clusters, improving sodium storage capacity. Moreover, they discovered that solid electrolyte interphase originates from sodium fluoride (NaF) forming on the hard carbon surface, with sodium carbonate (Na_2CO_3) embedded within the layer.



Researchers could then derive a possible explanation of the behaviour of Na^+ ions in hard carbon during sodiation: actually, ions are adsorbed on the hard carbon surface and inserted between graphene layers and then fill the pore walls. Here, if the pores are large enough (i.e., if carbonisation temperature is high enough), quasi-metallic Na clusters are formed at the end of the process. Underpotential sodiation leads to Na metal plating, with distinct NMR chemical shifts reflecting the different properties of plated Na and dendrites.

This in depth understanding of structures and dynamics can help enhance the performance of sodium-ion anodes, allowing the development of more efficient and long-lasting batteries.

With this highlight and the related papers, we would like to remember ***Prof. Dr. Gregor Mali****, distinguished researcher at CERIC's Slovenian PF and one of the most renowned scientists worldwide in the field of NMR research on porous materials.*

Figure 23
A recap of the measurements carried out in study (1), that allowed scientists to (i) provide an in-depth analysis of the formation and composition of SEI, (ii) understand and differentiate the sodium storage processes, and (iii) distinguish between Na metal plating and dendrite growth.

[18] *Probing sodium structures and dynamics in hard carbon for Na-ion batteries using 23Na operando solid-state NMR spectroscopy,* Gabrijelčič M., Tratnik B., Kapun G., Tchernychova E., Zabukovec Logar N., Krajnc A., Dominko R., Vizintin A., Journal of Materials Chemistry A, 2025, 13, 1042-1056, DOI: https://doi.org/10.1039/D4TA07135B

Structural and chemical analysis of hard carbon negative electrode for Na-ion battery with X-ray Raman scattering and solid-state NMR spectroscopy, Rajh A., Gabrijelčič M., Tratnik B., Bučar K., Arčon I., Petric M., Dominko R., Vizintin A., Kavčič M., Carbon, 2024, 228,119398, DOI: https://doi.org/10.1016/j.carbon.2024.119398

X-ray Diffraction, X-ray absorption spectroscopy

X-ray techniques describe modifications in the cathode material of aqueous Zn-ion batteries[19]

BATTERIES | ENERGY

Aqueous zinc-ion batteries (AZIBs) have been attracting an increasing interest in the field of energy storage research and in the rechargeable battery market, due to the advantages of its components: zinc presents low cost, nontoxicity and interesting electrochemical properties, while the aqueous medium gives the opportunity to avoid highly toxic, flammable and expensive organic solvents.

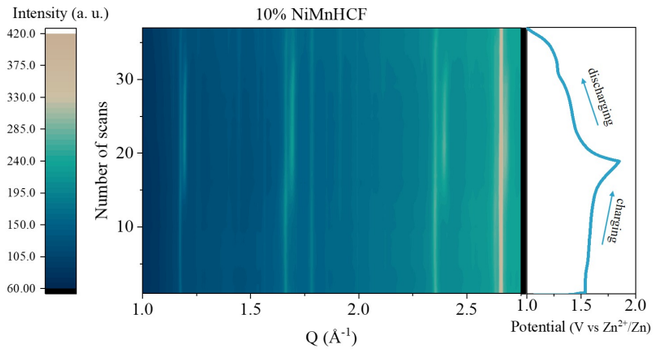


Figure 24
Operando PXRD measurement of NiMnHCF during the first cycle of Zn/NiMnHCF cell, with corresponding charge/discharge profile.

CERIC PhD candidate **Dr. Mariam Maisuradze, Prof. Marco Giorgetti** (University of Bologna) and colleagues followed the electrochemical behaviour of a partially (10%) nickel-substituted manganese hexacyanoferrate used as cathode material in a AZIB system, monitoring the structural modification of the material using synchrotron-based x-ray techniques. In particular, scientists exploited XAS and the powder x-ray diffraction (PXRD), both available at the CERIC Italian Partner Facility at Elettra.

Combining the two techniques – XAS helps to outline the electrochemical activity of metals used in cathodes and their local structure, while *operando* PXRD allows to describe the crystallinity, symmetry, unit cell parameters and phase modification of the used material during the operational conditions, and their changes during the aging process – researchers could show the profound alteration that the system structure undergoes: the dissolution of both manganese and nickel has been observed, alongside with the substitution of manganese with zinc. Furthermore, scientists demonstrated a new zinc-containing phase formation, and the modification of manganese species.

These results may help shed light on the degradation processes occurring at the cathode in a AZIB system, enabling the development of longer-lasting next-generation batteries.

"The integration of two x-ray techniques gave us the possibility to follow the structural modification inside the electrode material and understand the working mechanism of Zn-ion battery".

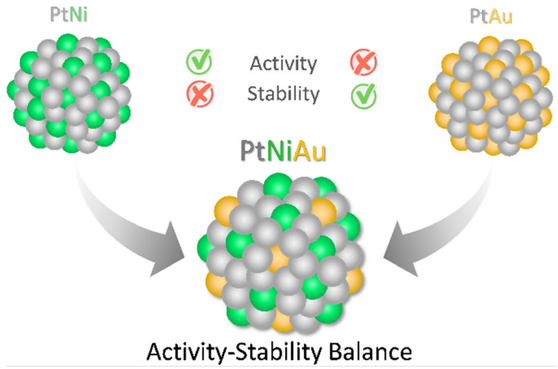
[19] *Structural Modification of Partially Ni-substituted MnHCF Cathode Material for Aqueous Zn-ion Batteries,* Maisuradze M., Li M, Gaboardi M., Aquilanti G., Plaisier J.R., Giorgetti M., Advanced Materials Science and Technology, 2024, DOI: https://doi.org/10.37155/2717-526X-0601-2

X-ray photoelectron spectroscopy

Unlocking the future of fuel cells with cost-effective and stable oxygen reduction catalysts[20]

ENERGY | FUEL CELLS

Cost-efficient and stable catalysts for the oxygen reduction reaction (ORR) are crucial for the advancement of energy technologies like proton-exchange membrane fuel cells (PEMFCs). A major challenge is the activity–stability trade-off: platinum alloys with transition metals such as nickel and cobalt improve ORR catalyst cost-efficiency but compromise durability, while platinum–gold alloys improve stability but reduce its activity and increase overall costs.



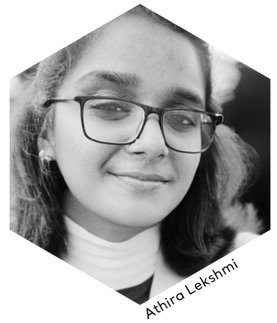
The optimal solution may lie in combining both approaches - using platinum alloys with transition metals to increase cost-efficiency while additionally incorporating gold for stability enhancement, and several studies on ternary Pt–Au–M catalysts have shown promising results. However, a deeper understanding of the underlying mechanisms and the detailed composition and distribution of elements in such complex alloys is essential for further progress.

Dr. Xianxian Xie, CERIC PhD fellow **Mgr. Athira Lekshmi MS**, their supervisor **Dr. Ivan Khalakhan** and colleagues from the Nanomaterials Group at the Charles University in Prague in collaboration with colleagues from Helmholtz Institute Erlangen-Nürnberg and University of Barcelona addressed this challenge by systematically investigating the correlation between composition, activity and stability of ternary PtNi–Au ORR catalysts prepared by magnetron co-sputtering. To do so, they applied several analytical techniques, including surface-sensitive Synchrotron Radiation Photoelectron Spectroscopy (SRPES), bulk-sensitive X-ray Photoelectron Spectroscopy (XPS) and the High-Resolution Field Emission Scanning Electron Microscopy (FESEM) available at CERIC Czech Partner Facility.

Scientsts found that incorporating 50% Ni into Pt increased ORR activity by 7 times. The addition of Au content from 3% to 15% in PtNi alloys led to a decrease in ORR activity but improved stability, demonstrated by suppressed Pt and Ni dissolution. Despite the reduced activity, the PtNi–Au alloy with 15% Au still demonstrated nearly three times the activity of monometallic Pt while showing superior stability compared to PtNi and even pure Pt.

These insights shed light on the delicate balance between activity and stability achieved through compositional engineering of multimetallic ORR catalysts, paving the way for the design of cost-effective, durable materials for PEMFCs.

Figure 25
Illustration of compositional engineering strategy to optimize activity-stability trade-off in ORR catalysts.



" By incorporating nickel and gold into platinum in optimal compositions, this study achieves a delicate balance between activity and stability, advancing cost-effective, durable catalysts for PEMFCs".

[20] *Balancing Activity and Stability through Compositional Engineering of Ternary PtNi-Au Alloy ORR Catalysts,* Xie X., Briega-Martos V., Alemany P., Lekshmi Mohandas Sandhya A., Skala T., Rodriguez M.G., Novakova J., Dopita M., Vorochta M., Bruix A., Cherevko S., Neyman K.M., Matolinova I., Khalakhan I., ACS Catalysis, 2025, DOI: https://doi.org/10.1021/acscatal.4c05269

Developing and characterising NiO-based gas sensors: innovations and challenges[21]

ENVIRONMENT

In the last 70 years, Semiconductor Metal Oxide (SMO) sensors have garnered significant attention for their role in monitoring environmental conditions, especially in industrial safety and pollution control. P-type SMOs, such as Nickel Oxide (NiO), offer a host of advantages, including high catalytic activity, low interference from background humidity, and the potential for low-power consumption. NiO was found to have good sensing response to gases such as hydrogen, methane, ammonia and nitrogen dioxide under various operating conditions. The gas sensing performance of the NiO nanostructures is significantly affected by factors such as grain size, morphology, surface defects, which depend on the synthesis route.

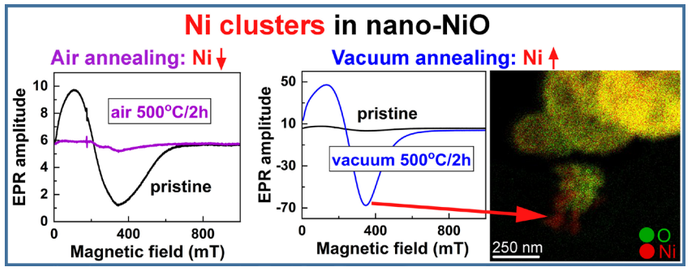


Figure 26
EPR and STEM-EDS evidence of the presence and evolution of Ni clusters in NiO nanoparticles annealed in air and vacuum.

Dr. Cristian Eugen Simion and a team of scientists from the National Institute of Materials Physics (Măgurele, Romania), including CERIC PhD fellow **Catalina Gabriela Mihalcea**, studied NiO nanoparticles obtained by hydrothermal synthesis at two different temperatures and subsequently submitted to various thermal treatments, to monitor the evolution of their morpho-structural properties and observe the effect of their thermal history on the CO sensing ability. To do so, they exploited several techniques, including Electron Paramagnetic Resonance and High-Resolution Transmission Electron Microscopy, available at the CERIC Romanian Partner Facility.

The NiO nanoparticles calcined at 400°C and 500°C exhibited marked differences in their morphology, defect structure, and gas-sensing performance. The annealing processes in vacuum and air induced further changes in these properties. The Electron Paramagnetic Resonance and Transmission Electron Microscopy studies revealed the presence of a minority phase of metallic nickel clusters in the superficial layer of the NiO nanoparticles annealed in vacuum, while air annealing resulted in the oxidation of these clusters, which significantly affected the sensor response to CO at 250°C operating temperature. The dissolution of nickel clusters induced a decrease in the concentration of free charge carriers, which are critical to the material's conductivity, and consequently led to an increase in the baseline resistance.

This intricate relationship between the NiO nanoparticles thermal history and gas-sensing performance highlights the importance of controlling the synthesis and post-synthesis treatment processes for developing highly efficient and stable gas sensors.

High Resolution Transmission Electron Microscopy, Electron Paramagnetic Resonance

"The in-depth investigation of hydrothermally synthesized NiO nanoparticles with different thermal history offered new insights into the factors that affect the gas-sensing performance of NiO nanostructures".

[21] *In-depth insight into the structural properties of nanoparticulate NiO for CO sensing*, Mihalcea C.G., Stefan M., Ghica C., Florea O.G., Stanoiu A., Simion C.E., Somacescu S., Ghica D., Applied Surface Science, 2024, DOI: https://doi.org/10.1016/j.apsusc.2023.159252

Externally-funded projects

In 2024, CERIC has been involved in several transnational science projects. One EU funded project (OSCARS) kicked off. The Horizon Europe (HE) projects IMPRESS, ERIC Forum 2 and ReMade@ARI, and the Marie Skłodowska-Curie Action project OPVStability continued to be implemented throughout the year.

HE project - ERIC Forum 2

The ERIC Forum 2 project, funded by the European Commission, gained momentum in 2024.
The project aims to develop a platform for collecting data and documentation about ERICs, work on implementing the ERIC Regulation, and enhance the ERIC community and its representatives' voice.
CERIC's contribution spans multiple areas. In collaboration with project partners, CERIC has coordinated the communication of both the project and the Forum, developed communication guidelines, and launched innovative initiatives, including periodic Slack community meetings to exchange best practices.
CERIC also conducted a comprehensive review of the ERIC employment contract types and established the foundation for the development of a European employment contract in the future. As an active member of various working groups, CERIC also helped designing and populating the data platform, identified improvement areas for the ERIC Regulation, and played a key role in supporting the ERICs' staff, especially promoting gender equality through dedicated initiatives.

HE project - IMPRESS
Interoperable electron Microscopy Platform for advanced RESearch and Services

IMPRESS is a European-funded project, which aims at designing and delivering cutting-edge Transmission Electron Microscopy (TEM) instrumentation, thanks to a close collaboration between scientists, companies, experts in the field of electron microscopy and RIs. The core principle of IMPRESS is the development of an interoperable platform based on modular, standardised and interchangeable components, which will facilitate a wide range of multimodal experiments, correlative workflows and methodological options (currently not available on commercially accessible electron microscopes).
In this framework, CERIC's role is to provide training to the scientific community about the developed technologies, and support communication and dissemination activities: to this end, CERIC organised and delivered (November 2024) together with Euro-BioImaging, the first IMPRESS online Training Workshop, "Collaborative Advancements in TEM". The two-day event gathered a diverse group of over 130 scientists, technologists and stakeholders. Selected speakers showcased leading-edge developments in TEM carried out within the project (including high-resolution electron sources, event-based detectors, real-time data processing tools, and in situ methodologies).
Thanks to a collaborative approach, the workshop has been a unique occasion to exchange ideas, solutions and applications among participants.

HE project - ReMade@ARI - REcyclable MAterials DEvelopment at Analytical Research Infrastructures

ReMade@ARI is a Horizon Europe project co-funded by UK Research and Innovation (UKRI) and by the Swiss State Secretariat for Education, Research and Innovation.
The project commits to supporting the development of innovative, sustainable materials for key components in the most diverse industrial sectors (such as electronics, batteries, vehicles, construction, packaging, plastics, textiles and food) on an unprecedented level, adopting a circular economy approach.
As part of the project, scientists have the unique opportunity to investigate the properties and structures of recyclable materials through a comprehensive range of tailored services. These include seamless, supported, and coordinated access to over 50 European analytical RIs (including CERIC) expert user support, and more.
In 2024, researchers have submitted proposals for Transnational Access (TNA) to several CERIC facilities, including the Slovenian NMR and the Polish synchrotron facility at SOLARIS. Additionally, a proposal for industrial access was submitted, reflecting the project's commitment to engaging SMEs and fostering collaborations with companies by providing access to CERIC techniques.

HE project - OSCARS - Open Science Action for Research & Society

A wide range of publicly funded RIs in Europe are organised in five major Science Clusters, each of which brings together the RIs within a specific domain: Astronomy and Particle Physics, Environmental Sciences, Life Sciences, Photon and Neutron science, and Social Sciences and Humanities. All of them work to achieve a greater FAIRness of science, contributing to making research data FAIR.
The Horizon Europe project OSCARS will strengthen the role of the Science Clusters in the ERA by consolidating past achievements into lasting interdisciplinary FAIR data services and working practices across scientific disciplines and communities, and by fostering the implementation of Open Science projects and services.
Its main objectives are thus to 1) Set up and implement Clusters' Open Science Competence Centres (CLOCCs), community-based virtual hubs dedicated to fostering research excellence through training and knowledge transfer; 2) Identify and provide Composable Open Data and Analysis Services (CODAS); 3) Contribute to a Data space for science, research and innovation, by supporting a number of Open Science projects via a cascading grant mechanism, with the goal of fostering the uptake of Open Science in Europe
The role of CERIC has been to coordinate the communication of both OSCARS, and of the projects funded via the OSCARS Open Calls for Open Science projects and services in collaboration with the project coordinator, CNRS and the OSCARS partner Trust-IT. In 2024, CERIC released the project Communication, Dissemination and Exploitation Plan, and supported the organisation and promotion of the 1st Open Call and of the activities in OSCARS work packages.

MSCA project - OPVStability
Understanding, Predicting and Enhancing the Stability of Organic Photovoltaics

The OPVStability Marie Skłodowska-Curie Actions Doctoral Network (MSCA-DN) is an interdisciplinary research training network of ten beneficiary universities from seven countries.
Funded under the *Excellent Science* cluster of the Horizon Europe programme, the project supports the research of ten PhD candidates investigating stability and degradation mechanisms in organic photovoltaics. In 2024, CERIC welcomed the PhD researcher Devina Gupta at the Austrian PF and began supporting her training and research activities. Her work focuses on examining how environmental conditions affect the stability and morphology of absorber layers and interfacial regions in organic solar cells. In the frame of the project, CERIC also organised the First Progress Meeting and established ongoing communication initiatives for the project.

2

Developing and strengthening CERIC's portfolio

Since its establishment, CERIC has been committed to supporting the development of its infrastructure and the continuous integration of national multidisciplinary PFs into a unique EU-level distributed RI. This integration is vital as it enables the sharing of resources, expertise, and data across borders, enhancing the efficiency and impact of research. Following directives from its GA, CERIC has actively supported joint research projects and the professional growth of young researchers and postdocs. It has also made significant investments in infrastructure enhancements.

Main Achievements in 2024

1. **Positive evaluation of the Hungarian and Polish PFs by international teams of experts led by CERIC's ISTAC.**

2. **Infrastructure upgrade**
   New accelerator building being constructed at the Croatian PF, equipment upgrade of the SPL and HTC laboratories at the Czech PF, modernisation work ongoing at the Hungarian PF, three new instruments installed at the Italian PF, two new beamlines constructed at the Polish PF (PolyX and CIRI), new 600 MHz NMR spectrometer purchased at the Slovenian PF.

3. **New instruments added to the CERIC open access offer: PolyX at the Polish PF, and IUVS OFF at the Italian PF**

4. **Four projects funded via the CERIC Call for Expression of Interest have been completed**

5. **Zdravko Siketić appointed as new Director of the Croatian PF**

Quality of Services

ISTAC's evaluation of CERIC's Hungarian and Polish PFs

On May 27th, and later on November 26th and 27th, 2024, the members of the CERIC's ISTAC performed the periodical evaluation of the Hungarian PF - the Budapest Neutron Centre hosted by the Eötvös Lóránd Research Network, Centre for Energy Research, EK-CER - and of the Polish PF at the National Synchrotron Radiation Centre SOLARIS in Krakow.

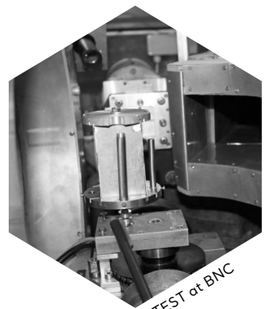
The purpose was to evaluate the performance of the PFs in terms of the quality of its scientific activities and its contribution to the common strategic objectives and access capabilities of CERIC, as well as the added value of the inclusion in the Consortium, for both the PFs and CERIC. The evaluation was conducted by an international Committee of Evaluators (CoE). In the case of Hungary, it was composed of **Andrew Harrison** (ISTAC Chair at the time), **Mark Robert Johnson** (external evaluator) and **Jürgen Neuhaus** (external evaluator). In Poland, evaluators included ISTAC members **Christoph Quitmann, Karsten Horn**, **Annalisa Pastore**, and **Andrew Harrison**[22].

At the Hungarian PF - where Zoltán Dudás was appointed as new PF Director in 2024 - the CoE noted significant improvements since the last CERIC review in neutron tomography with cold neutrons at the NORMA facility, although a number of instruments still require significant upgrades.
There has also been an increase in the number of scientific publications and of proposals, as well as a higher user satisfaction with reference to beamline support, with 85% of users rating it as excellent, up from 81% in the previous evaluation. This improvement underscores the positive impact of targeted efforts to enhance user support and interaction, which is crucial for maintaining and expanding the user base.


Reactor hall at BNC

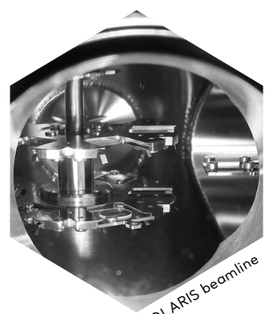
The importance of the ongoing efforts towards training young scientists through courses related to BNC's instruments at national universities for Master and/or PhD students, as well as the biennial international Central European Training School (CETS), was emphasised, not only for being commendable and vital for developing future talent in the field, but also for the potential these activities have in further increasing the attractiveness for international scientists to use the BNC and foster its role in CERIC participation.

The CoE also provided a set of recommendations and suggestions to further enhance the efficiency of the Hungarian PF, with a view to continuous improvement of CERIC's scientific open access offer.


MTEST at BNC

It is also important to note that, in the specific case of Hungary, CERIC has been actively engaged in discussions with the national research agency HUN-REN to make the case for the BNC as a critical centre of neutron science in Europe, being one of the few remaining centres after a massive closure of similar infrastructures around the continent. In this respect, former CERIC ED Jana Kolar, current ED Andrew Harrison and GA Chair Carlo Rizzuto are all members of a HUN-REN working group providing expert advice on options for future neutron facilities in Hungary.

At the Polish PF, the CoE was very positively impressed by the remarkable expansion in capacity and capability since the previous evaluation in 2020.
The evaluation report will be released in 2025 after finalisation by the ISTAC of CERIC.


SOLARIS beamline

[22] Andrew Harrison (formerly: Extreme Light Infrastructure ERIC), Mark Robert Johnson (Institut Laue Langevin), Jürgen Neuhaus (Maier-Leibnitz Zentrum), Christoph Quitmann (Division Project LightHouse, RI Research Instruments GmbH), Karsten Horn (Fritz Haber Institute of the Max Planck Society in Berlin), Annalisa Patore (ESRF).

CERIC's support to the strengthening of its capabilities

In line with its Statutes and strategy, CERIC has been continuously supporting the integration of its national multidisciplinary PFs into a unique EU-level distributed RI. This integration is vital as it enables the sharing of resources, expertise, and data across borders, enhancing the efficiency and impact of research.

Following directives from its General Assembly, CERIC has actively supported joint research projects and the professional growth of young researchers and postdocs by co-funding PhD scholarships and projects for postdocs in collaboration with several universities in Europe. It has also made significant investments in RI enhancements, through the projects funded via the 2022 Call for Expression of Interests, which aimed to provide to CERIC PFs, research grants and RI development funds.

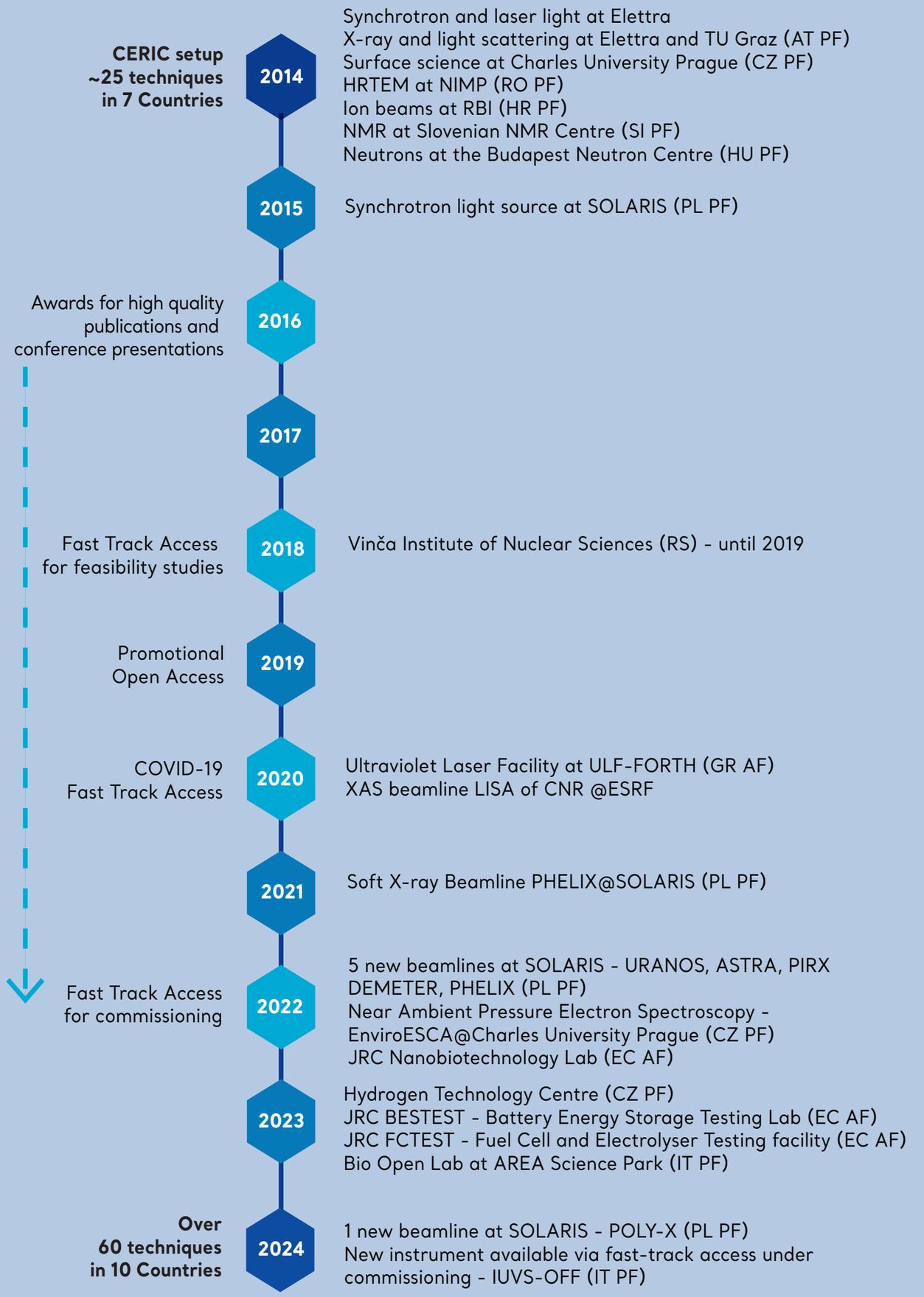
Such initiatives were organised through internal calls proposed by the ED in consultation with the BoD, managed by the ISTAC, with the outcomes approved by CERIC's GA. This structured approach has ensured that the activities align with CERIC's strategic objectives and meet the highest standards of excellence and relevance.
To support these activities, CERIC devoted part of the annual ordinary funds coming from the Italian Ministry for University and Research.

In addition, following the adoption of the new CERIC funding model in 2024 - which foresees that the total annual contribution of the country presently hosting the Statutory Seat will be maintained at 5,5 M EUR and that, starting 2024, CERIC Member Countries will also provide annual membership fees - the additional funds coming from Members' contributions will be used for further developing the infrastructure, as well as for appointing new scientific and technical personnel at the PFs.
In this framework, in 2024 several activities were funded in the amount of 77,868.40 EUR.

These also included the activities foreseen in the report by the expert groups on Battery[23] and Fuel Cell[24] research, , aimed to boost CERIC's role in fostering a transition towards renewable energy by developing specialised access for hydrogen and battery research, as well as by broadening its array of advanced analytical techniques, which now support a diverse range of experiments aimed at developing next-generation energy materials and devices.

Below, a summary of the main activities is provided, illustrating the specific contribution and achievements for each Member Country.

[23]B. Bozzini, A. Iadecola, L. Stievano, Report of CERIC's Expert Group on Batteries, 2020, https://doi.org/10.5281/zenodo.3891479
[24]B. Bozzini, S. Cavaliere, J. Drnec, M. Tromp, CERIC-ERIC Report of the Expert Group on Fuel Cells, 2021, https://doi.org/10.5281/zenodo.5720332



AUSTRIA

In 2024, the CERIC Austrian Partner Facility prepared for the ELETTRA 2.0 upgrade, with installation set for mid-2025 and the new storage ring restart planned for 2027. In parallel, at both, Graz University of Technology (TUG) and ELETTRA, continued instrumentation refurbishments to serve the CERIC community at top-level.

At the **SAXS laboratory instrument at TUG**, a new data pipeline and new control software enabling programmed control were implemented, increasing throughput and broadening usability for internal and external users. At the **DXRL beamlin**e, a new microfabrication capability was installed, funded by CERIC and external sources, and will be accessible to other Partner Facilities (PFs) and external users.

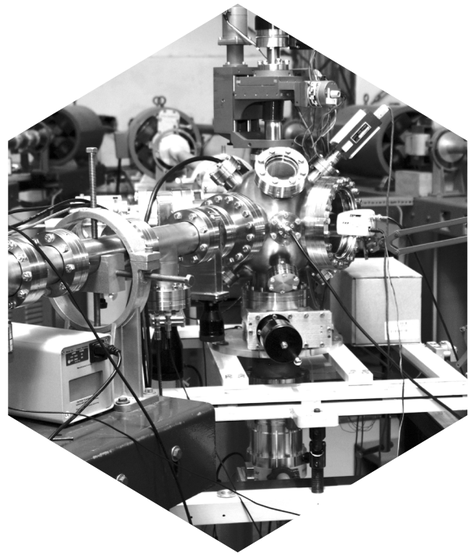
A CERIC PhD student began work at the Austrian and Italian PFs within the **Horizon Europe MSCA-DN project OPV Stability**, coordinated by TUG, aimed at enhancing organic photovoltaics stability through experimental, high-throughput, and machine learning approaches.
The CERIC **HR project INCITE** contributed to MOF research for renewable energy storage, photoswitching, and CO_2 capture, resulted in an accepted Nature Communications publication. In parallel, a CERIC-funded **Ukrainian postdoc** began related work on MOF film growth using a layer-by-layer approach.

Looking ahead, the Austrian PF remains closely involved in the ELETTRA 2.0 upgrade. The new **HF-SAXS beamline** ("new AustroSAXS"), fully integrated in the CERIC user program and partially supported by CERIC, is among the first to be in operation after the 2027 restart. A further SAXS lab upgrade is planned for 2025.
In 2024, CERIC and its Austrian and Czech PFs successfully applied to the HORIZON-INFRA-2024-TECH-01 call with the **ACTNXT project**—Advanced Characterization of Technical Components for New Power-to-X Technologies—which has been funded and will start in 2025.

TECHNIQUES AVAILABLE:
Austrian Small Angle X-ray Scattering beamline, Deep X-ray Lithography (DXRL) Beamline & Microfabrication Laboratory, Laboratory SWAXS and Dynamic Light Scattering (DLS)

RESEARCH DOMAINS:
Chemistry, physics, biological sciences, life sciences, materials science.

CROATIA



In 2024, the CERIC Croatian PF at the Ruđer Bošković Institute (RBI) in Zagreb appointed Zdravko Siketic as new Director, taking over the position of Milko Jakšić. Moreover, several upgrades took place for the continuous development of the infrastructure. In this respect, RBI has been participating in the EU Infrastructure project O-ZIP, under which a new accelerator building has been constructed, while a new 5 MV Tandem accelerator will replace the existing 6 MV VDG accelerator. The construction is expected to be completed by June 2025, with the laboratory relocated and partially operational by the end of 2025. The delivery of the 5 MV Tandem accelerator is scheduled in the second half of 2025, and the laboratory is expected to be fully operational by spring 2026. In this project, the insulating SF_6 gas required for accelerator operation has been purchased through the CERIC using the membership fee funds.

The Croatian PF applied to the 2022 CERIC Call for Expression of Interest to get Research Grants and Infrastructure Development funds and got four projects funded, two of which have already started:

- The **EXIT** project aims to develop a state-of-the-art system based on a scanning microbeam with the smallest possible spatial resolution in air and the highest possible solid-angle detectors for Particle Induced X-ray Emission (PIXE) and Particle-Induced Gamma-ray Emission (PIGE) analysis techniques. It will be used for the analysis of cultural heritage objects, the characterisation of complex detectors and electronics, in *operando* analysis of components in energy storage and conversion devices, and biomaterials analysis, including irradiation of living cells.
- The **Triple I** project will upgrade the recently installed 200 keV implanter/accelerator to extend the range of the tandem accelerators at RBI to energies below 200 keV. The upgrade includes the installation of a new ion source, a new end station/analysis chamber, and a stable power supply for the analysing magnet.

Another valuable collaboration is that with one of the members of the CERIC expert group on batteries, Benedetto Bozzini, from the Politecnico di Milano, focusing on applying the microPIXE technique for ex-situ battery characterisation. The results were presented at the ICNMTA2024 conference by CERIC postdoc, Dr. Sabrina Gouasmia. In addition, within this project, RBI obtained the LaBr gamma detector – financed by CERIC – for high efficiency PIGE analysis of light elements with application to battery studies.

When looking to the future, RBI expects to have an increase in the number of CERIC users from the fields of biology, forensics, cultural heritage, and material science applying for MeV Time-of-Flight Secondary Ion Mass Spectrometry analysis, a technique recently added to the CERIC portfolio.

Moreover, by spring 2026, the new laboratory is expected to be fully operational and available to CERIC users, offering higher ion beam energies and currents, as well as an additional beamline for in-air micro-PIXE and Rutherford Backscattering (RBS), developed under the CERIC-funded project EXIT.

Finally, by the end of 2026, the upgrade of the 200 keV implanter, funded by the CERIC-funded project Triple I, is expected to be completed, making it available for CERIC users for low-energy ion beam implantation.

TECHNIQUES AVAILABLE:
Dual Beam Irradiation Station, Ion Beam Channeling , MeV Time-of-flight (ToF) Secondary Ion Mass Spectrometry, Nuclear Microprobe, Detector Testing, Particle-Inducted X-ray Emission, Rutherford Backscattering, ToF Elastic Recoil Detection Analysis

RESEARCH DOMAINS:
Material physics, semiconductors, batteries-thin films, elemental analysis, microimaging, Radiation detectors and dosimetry, Molecular imaging, materials physics, nuclear fusion and fission, Ion beam implantation and materials modification,
biomedicine

CZECH REPUBLIC

In 2024, at the CERIC Czech PF of the Charles University Prague - the Surface Physics Laboratory – Hydrogen Technology Center (LRI SPL-HTC), located in Prague and Trieste - continued to conduct cutting-edge research in materials and chemical engineering and biophysics through its users, with a focus on the development of advanced materials and their properties and technologies in strategic areas, such as sustainable energy.

The LRI, through CERIC, has offered and provided open access to users worldwide to its facilities - the Materials Science Beamline (MSB), XPS/XPD, NAP-XPS, and EnviroESCA spectrometers, FE-SEM and LYRA FIB/SEM microscopes, and the Hydrogen Technology Centre's devices - half cells and single cells of the water electrolyser (WE) and hydrogen fuel cells (FC).

In 2024, through the CERIC Calls for proposals, the Czech PF attracted 109 users. In the same year, 78 experiments were carried out - 27 more than the previous year. This number includes the projects selected via the CERIC call for proposals, as well as projects requesting fast-track access. At the HTC, which has been added to the CERIC open access offer only in the second half of 2023, twelve experiments were conducted in 2024 - which can be considered quite successful.

Although more applicants participated in the 2024 SPL-HTC time measurement competition, the previously abundant user base from Ukraine was almost zero in number due to the ongoing war. On the other end, compared to the previous year, there has been a noticeable increase in proposals from Czech users, from 24 to 40%, which is reflected in higher numbers of allocated experiments on SPL/HTC devices – from 29 to 51%, and high-pressure photoelectron spectrometers are in great demand by users for *operando* studies.

According to the original plan, surface electrochemistry and the *operando* approach are in the process of being further developed within the LRI. In 2024, an *operando* minicell of the water electrolyser that can be operated inside the EnviroESCA apparatus was introduced to users. During its operation, the chemical composition and electronic structure changes of the material can be studied using XPS[25]. This mini-WE is starting to be in high demand and is also behind most fast-track proposals.

The issue of *operando* techniques is also being addressed by the SPL-HTC team in the context of intense CERIC internal cooperation, in particular with the team of Dr. Heinz Amenitsch from the CERIC Austrian PF. Significant successes have been achieved by the SPL-HTC team in collaboration with colleagues from the SAXS and XAS beamlines at the Elettra synchrotron[26] and colleagues working at the ID31 beamline at ESFR[27]. For these specific facilities, prototype *operando* cells have been designed, fabricated and tested to study changes in the structure of materials during operation of WE and FC cells.
An upgrade of the equipment in the Prague SPL and HTC laboratories has also been initiated and linked with the development of knowledge and experience of the LRI team in the field of hydrogen technologies.

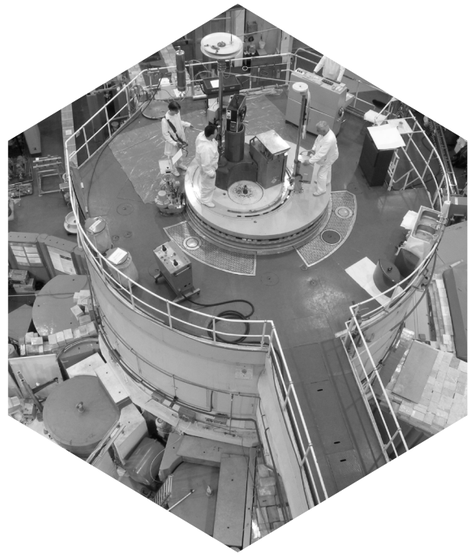
The LRI SPL-HTC operations - including user support - were covered by the project LM2023072 of the Czech Ministry of Education, Youth and Sports. Moreover, In 2024, the CERIC Czech and Austrian PFs applied to the HORIZON-INFRA-2024-TECH-01 call with the project ACTNXT - Advanced Characterisation of Technical Components for New Power-to-X Technologies, which was funded and will start in 2025.

TECHNIQUES AVAILABLE:
Materials Science Beamline, XPS/XPD, NAP-XPS, and EnviroESCA spectrometers, FE-SEM and LYRA FIB/SEM microscopes and the HTC devices – half cells and single cells of the water electrolyser (WE) and hydrogen fuel cells.

RESEARCH DOMAINS:
Surface science, materials science, catalysis, physical chemistry, Biophysics, Sensors, energy materials, electrochemistry, hydrogen technology

[25]For more details, read the article at this link: https://doi.org/10.1016/j.ijhydene.2023.12.216
[26]Read more at https://doi.org/10.1016/j.ijhydene.2024.01.261 and https://doi.org/10.1016/j.jpowsour.2024.235070
[27]Read more at https://doi.org/10.1016/j.jpowsour.2023.232754

HUNGARY



At the end of 2023, the CERIC Hungarian PF at the Budapest Neutron Centre obtained a 10-year licence extension for the Budapest Research Reactor. In 2024, restarting the reactor posed several challenges that have been largely addressed through the required modernisation work and the appointment and training of sufficient technical staff. The modernisation work and the training of the staff are expected to be completed by mid-2025, after which the Budapest Research Reactor will resume its normal operating routine.

The control system of the YS-SANS instrument has been successfully transferred to a newly developed Python-based software. This software provides a Graphical User Interface (GUI) that seamlessly connects to the Programmable Logic Controller (PLC), controls motor movements, and facilitates communication with auxiliary devices, including the thermostat and high-voltage supply.

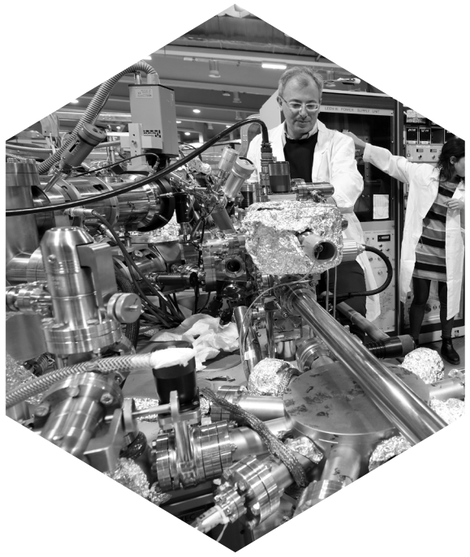
With respect to the relevant projects implemented, whose aims are linked to CERIC mission and key objectives, the EU multilateral project SELFAQUASENS aimed at developing nanostructured sorbent materials for removal of toxic metal ions from aqueous environment. New silica-based selective adsorbents were synthesized, characterised, and tested for the adsorption of arsenic and various rare earth metals.

In the near future, the renewal of the neutron guide system of the BNC cold neutron instruments is scheduled, as well as the start of the new CERIC-supported two-year project InNeuRam4Sos.

The InNeuRam4Sos project, to be implemented together with the Italian PF, aims to establish a geographically-distributed, scientifically-integrated platform for CERIC users focused on studying associated liquids and their structural and intermolecular properties. The objective is to develop a station equipped with structure-sensitive probes and experimental expertise alongside innovative data analysis methodologies to cater to the needs of both academic and industrial users in Solvation Science. HR activities will focus on enhancing collaborative research across facilities by integrating complementary techniques such as neutron and UV Resonance Raman scattering. The capabilities of this new interconnected experimental station will be demonstrated through the study of miscible aqueous solutions of model ionic liquids.

TECHNIQUES AVAILABLE:
Small angle neutron scattering

RESEARCH DOMAINS:
Structural research of condensed matter at mesoscopic length scales



ITALY

The successful response of the CERIC Italian PF at Elettra Sincrotrone Trieste, to the 2022 CERIC call for expression of interest allowed three new instruments to be installed at its premises:

- Thanks to the **FAITH project**, a micro-CT apparatus will be added to the SYRMEP laboratory, allowing the TOMOLAB offline facility to be included in the Elettra and CERIC open access offer from the next call for proposal.
- Thanks to the **ESBY project**, the new cryo-confocal microscope Stellaris 5 by Leica will be installed and included in the open access offer.
- Thanks to the **STEAM - multiScale TErAhertz iMaging project,** a new offline instrument for the TeraFERMI beamline is now fully operational, to offer both free-electron-laser and table-top spectroscopic techniques.

In 2024, Elettra and CERIC jointly participated in the ReMade@ARI Horizon Europe project, offering TNA to analytical tools, instrumentation, methods and know-how, to explore the properties and structure of materials right down to atomic resolution. Moreover, Elettra joined CERIC as Associated Partner in the WIDERA Action ERA_SHUTTLE and will welcome experienced researchers to its premises.

Starting 2025, the installation of the new Elettra 2.0 machine will begin at the CERIC Italian PF. The new source will exhibit a major increase in the brilliance and coherence fraction of the photon beams. The Elettra 2.0 optics is based on an enhanced symmetric six bend achromat structure (S6BA-E) with a 12-fold symmetry and an emittance of 200 pm-rad at 2.4 GeV. The new structure creates also straight sections in the arcs, permitting the installation of additional insertion devices, thus increasing the number of beamlines. Existing beamlines are being upgraded, and new beamlines will be installed to take full advantage of the characteristics of Elettra 2.0. The new machine is scheduled for commissioning in the second half of 2026.

Elettra is committed to assist researchers in delivering the best Science with state-of-the-art instruments. During the update of the Elettra storage ring, the FERMI free electron laser will be open to users and several offline instruments have been updated and commissioned to ensure the scientific activity of the Elettra team and the corresponding offer to users will remain at word-top levels.

The offer to CERIC users will include the following:

- Tomolab, A laboratory for X-ray computed tomography (CT) – new entry
- TeraFERMI, The THz beamline of the FERMI Free-Electron-Laser (FEL) facility – new entry
- IUVS OFFLINE laboratory (added again in 2024 to the CERIC portfolio, among the instruments accessible via fast-track under commissioning).
- SISSI OFFLINE Laboratory

TECHNIQUES AVAILABLE:
Photoemission, spectroscopy, crystallography, small-angle X-ray scattering, imaging at micro and nanoscale, x-ray imaging, IR microscopy.

RESEARCH DOMAINS:
materials science, surface science, solid-state chemistry, atomic and molecular physics, biology, medicine, cultural heritage

POLAND

In 2024, the CERIC Polish PF at the National Synchrotron Radiation Centre SOLARIS in Krakow, completed the construction of two beamlines and introduced several significant upgrades to the existing infrastructures.

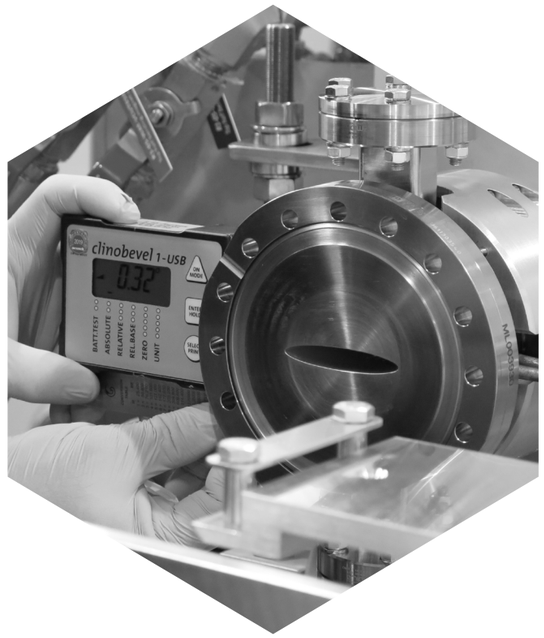
The **CIRI beamline** - soon to be available to users - has been equipped with three state-of-the-art infrared microscopes that can be used for biomedical imaging, analysis of the composition of polymeric and inorganic materials, and research on electronic properties of two-dimensional materials.

The **PolyX beamline** was added to the portfolio of instruments and techniques available via CERIC open access. It offers X-ray microimaging and X-ray micro spectroscopy in the energy range 4-15 keV, and enables imaging of 2D and 3D structure, elemental distribution, and chemical phases of solid and liquid samples.

The angle resolved photoelectron spectrometers at the **URANOS and PHELIX beamlines** were upgraded with spin filters that open a new dimension in research of topological matter and quantum materials. Moreover, the **ASTRA beamline** was equipped with RAMAN spectrometer for simultaneous inspection of materials' evolution during *in situ* and *operando* XAS investigations, whereas the **PIRX beamline** now offers a new detection mode: partial electron yield (PEY) using multichannel plates with delay voltage, which is particularly useful in examination of insulating materials with low elemental concentrations.

Several experiments were performed in 2024, in the frame of the Remade@ARI project, in which CERIC is also a partner. Moreover, the project **CECOMEC – Tuning CEria-based COMpounds as effective catalyst for Electrochemical Cells** - submitted in the frame of the 2022 CERIC Call for Expression of Interest - was funded and launched in 2024. The project involves CERIC, CNR – Istituto Officina dei Materiali, the Gdansk University of Technology and SOLARIS.

In the domain of training, and as part of the project PRP@CERIC - Pathogen Readiness Platform for CERIC-ERIC Upgrade, the Structural Biology School was held at SOLARIS in November 2024, with a programme including a series of lectures and practical workshops, as well as a segment on cryo-electron microscopy led by the Cryo-EM Team at SOLARIS.



TECHNIQUES AVAILABLE:
Photoemission, spectroscopy, X-ray spectroscopy, X-ray transmission and fluorescence microscopy, X-ray tomography, angle- and spin-resolved photoelectron spectroscopy, photoemission spectroscopy and microscopy, cryo-EM.

RESEARCH DOMAINS:
Chemistry, physics, biological sciences, materials engineering, geology and earth sciences, paleontology

ROMANIA

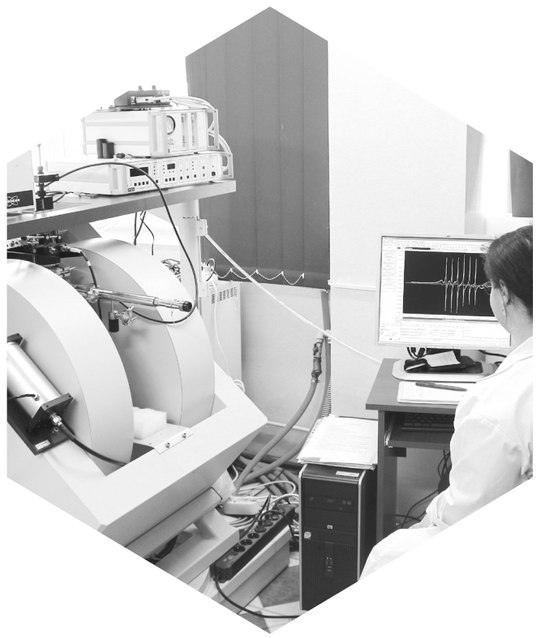
The CERIC Romanian PF at the National Institute of Materials Physics (NIMP) in Măgurele positively responded to the 2022 CERIC call for expression of interest, through which it got one project funded, titled “Atomic resolution analytical TEM/STEM facility for correlative microstructural and functional in situ and *operando* investigations”.
The project aims to upgrade of the existing HRTEM RI at NIMP, to facilitate the approach of *in situ* and *operando* analytical TEM/STEM on functional materials for energy and semiconductor industry.

The project is currently being implemented by running the procedures to procure and install a new nanomanipulator for complex and precise nanoscale manipulation and preparation of micro-objects using the ion beam of the Tescan Lyra III SEM-FIB instrument for *operando* TEM investigations, and a new EDS spectrometer on the JEM ARM200F atomic-resolution transmission electron microscope for qualitative and quantitative analytical investigations with high spatial resolution.

With reference to the projects whose aims are linked to CERIC mission and key objectives, a research direction has been launched within the internal Core Research Programme of NIMP on materials for post-Li solid state batteries.

Furthermore, additional activities to further improve the infrastructure are planned in the future. These include:

- The extension of the current HRTEM&EPR facilities - both in terms of infrastructure and scientific / technical expertise - for *in situ / operando* investigation on materials for energy.
- The development of a set-up and protocol for ESR spin-trapping experiments.
- The acquisition of an electrochemical cell for in-situ EPR.
- The development of the infrastructure for TEM specimen preparation with an ultramicrotome for soft, solid-state and hybrid materials.
- The upgrade of the *in situ/operando* TEM facilities to simultaneous heating and biasing of the specimen during nanoscale structural and compositional investigations.



TECHNIQUES AVAILABLE:
HRTEM, EPR

RESEARCH DOMAINS:
Materials Science

SLOVENIA

In 2024, the CERIC Slovenian PF - the Slovenian NMR Centre at the National Institute of Chemistry in Ljubljana - launched a Public Call for the purchase of a new 600 MHz NMR spectrometer (Bond), which will be primarily intended for measurements of solid samples.
Fifty percent of the necessary funds were obtained through the ARIS' (Slovenian Research and Innovation Agency) Public Call for Co-financing the Purchase of Research Equipment, and the remaining 50% of the funds were contributed by CERIC through the CERIC RI Development Call.
The spectrometer was delivered in October 2024 and installed in the previously renovated premises of the Slovenian NMR Centre (SloNMR). It will be available to CERIC users starting 2025.

Also, the PF started implementing the two-year postdoctoral project DNANANOCERIC - submitted to the 2022 CERIC Call for Expression of Interest - where CERIC has been funding the employment of a postdoctoral student who will carry out experimental work at the SloNMR. In addition, the PF is the lead mentor of two doctoral students employed at the SloNMR and funded directly through CERIC.

Furthermore, the Slovenian PF has also planned to further upgrade its equipment by purchasing a 1.0 GHz NMR spectrometer for studies in solutions, and an 800 MHz wide bore NMR spectrometer in combination with a DNP, for studies of solids.

Finally, the training of personnel will continue in the field of NMR spectroscopy, as only highly qualified researchers and experts can use their knowledge and expertise to solve professional problems for the widest range of users.

TECHNIQUES AVAILABLE:
NMR spectroscopy in liquid- and solid-state

RESEARCH DOMAINS:
Chemical analysis and identification, determation of 3D structures and dynamics of small and (bio-)macro-molecules and their complexes, tracking chemical reactions in (bio-)analytical procedures, studying polycrystallinity and identifying metabolites and amorphous forms, characterization of different materials, including batteries (in operando).

Enhancing PFs' capabilities

COMPLETED PROJECTS

600 SSNMRCERIC, 600 MHz NMR spectrometer for measuring solid samples
Slovenian PF

Replacing the three decades-old Varian 600 MHz NMR system (Magic) that was offered to CERIC users before, the new state-of-the-art 600 MHz NMR spectrometer (Bond) installed at the Slovenian PF guarantees stable, long-term operation supported by reliable technical assistance. Equipped with specialised probes and advanced technology, this system significantly enhances capabilities for high-resolution solid-state NMR experiments and diffusion measurements. Remarkably, this magnet is among the first of its kind installed worldwide, substantially reducing its energy footprint through minimal liquid helium consumption.

Importantly, the system is designed to accommodate future upgrades, including potential additions of advanced techniques, such as Dynamic Nuclear Polarization (DNP), ultrafast magic-angle spinning (MAS) and low-temperature probes. These future expansions could further enhance research opportunities in materials science, battery technologies, pharmaceuticals, semiconductors, optical materials, and catalysis. By offering detailed insights into structural parameters and diffusion processes, the spectrometer facilitates groundbreaking research and practical material innovation.

This upgrade represents a major advancement for the SloNMR, aligning with the strategic objectives of Slovenia and CERIC for promoting research excellence and innovation. Accessible to all partners interested in utilising its advanced capabilities, the new equipment encourages collaborative research, enhancing scientific expertise and regional competitiveness. Completed in December 2024, this installation sets the stage for transformative discoveries and a sustainable future in solid-state NMR research in Slovenia.

ESBY, Electron microscopy for Structural BiologY at CERIC-ERIC
Italian PF and CNR-IOM, Italy

The Italian National Research Council and Elettra have been setting up a cryo-electron microscopy facility for CERIC users at the Elettra premises, in the frame of the project PRP@CERIC, “Pathogen Readiness Platform for CERIC-ERIC Upgrade”, led by Area Science Park under the PNRR (National Recovery and Resilience Plan) funded by the European Union – Next Generation EU.

The ESBY project contributed to set up and strengthen the cryo-EM facility at the AREA Science Park, providing CERIC with a state-of-the-art cryo-confocal microscope (Stellaris 5 by LEICA) and a cellular cryo-sample preparation system (EM GP2 by Leica) for Cryogenic Electron Tomography - cryo-ET. Cryo-ET has revolutionised the visualisation strategy of molecular structures in near-native states. Despite the impressive breakthroughs in both hardware equipment and software algorithms, cryo-ET pipelines are still demanding, and cryo-ET is still a niche area where the Trieste cryo-EM facility could position itself strategically.

The installation has been conceived complementary to the CERIC cryo-EM at the Polish PF SOLARIS, where a 300kV Titan Krios G3i cryo-EM for single particle analysis is available. Combining micro-diffraction capabilities at micro-XRD beamline in Elettra 2.0, single particle cryo-EM and cryo-ET will provide CERIC users with a comprehensive platform able to bridge conventional structural analysis with in-cell structural biology.
The selected confocal microscope also allows super-resolution imaging of room-temperature samples, which makes the instrument available for a wider range of applications in Life Sciences and Soft Matter, making it a promising complementary tool to a wide set of CERIC instruments, for X-ray imaging, IR and UV radiation hyperspectral imaging, as well as genomic and proteomic/metabolomic imaging.

STEAM, multiscale TErAhertz iMaging
Italian PF

Thanks to its penetration properties, chemical specificity, and safety, THz light provides the perfect solution to address many scientific and societal problems in fields as diverse as biomedicine, cultural heritage, semiconductors, pharmaceutics, agriculture, biochemistry, and security. Thanks to the STEAM project co-funded by CERIC and Elettra, the TeraFERMI facility @FERMI allows performing both far-field and near-field THz hyperspectral imaging, from the mm to the nm-scale.

THz provides the ideal complementary investigation tool with respect to other vibrational spectroscopies, such as infrared and inelastic scattering. In many cases, sample preparation is also expected to be similar between these techniques, thereby even allowing multi-technique studies on the very same sample.

Potential applications span a wide range of disciplines:

- **Biosafety**: Fast identification of microorganisms and pathogens, also on real objects, or on different types of substrates mimicking real case applications, such as food, toys, books, handrails, glass dividers, coins, etc.
- **Agriculture**: Analysis of water absorption and distribution mechanisms, for instance in plant leaves, thereby gaining insights on plants physiology and allowing to optimise irrigation strategies.
- **Cultural heritage**: Non-destructive in-depth cross-section imaging thereby allowing the evaluation of cracks and fractures in hidden buried layers, such as in painted woods, or ceramics.
- **Pharmaceutical**: Distinguishing between polymorphs of chemical substances, which may affect dissolution rates, solubility, stability and biological performance. Analysis of coating thickness and tablet porosity.
- **Electronics**: Imaging of integrated circuits, even buried in plastic packaging, and analysis of their carrier concentration.
- **Plasmonics**: Terahertz nanoscopes allow the generation and study of surface plasmons, which represent the most promising route towards the integration of photonics and electronics on the nanoscale.

INCITE, probing dyNamiCs In sTructures for Energy-storage
Austrian, Italian and Slovenian PFs

The INCITE project was conceived with the primary objective of advancing the development of phase-change materials, with a particular emphasis on metal-organic framework (MOF) films, for cutting-edge applications in renewable energy storage and management. The successful realisation of this objective not only resulted in the creation of novel materials and characterisation techniques but also significantly strengthened scientific collaboration across CERIC partner facilities. In particular, the partnership between the SISSI-Bio OFF beamline and the Technical University of Graz was notably deepened, fostering enhanced research synergies and shared expertise. Additionally, the collaboration was further extended to include the TeraFERMI beamline and TeraFERMI Offline facilities, which were recently integrated into the CERIC framework. This expansion of collaborative activities broadened the scope of experimental capabilities available to the Consortium, further reinforcing the RI supporting INCITE’s objectives.

Specific highlights are the research regarding the synthesis of CL-DMOF-1, a Zn_2Cl_2-BDC_2DABCO framework, by incorporating the 2,5-dichloroterephthalate linker. Additional functional groups such as methyl, methoxy, hydroxy, and amine were incorporated; however, only methyl and methoxy groups successfully led to the growth of the desired structure. The amine group resulted in a different framework, while the hydroxy group did not promote growth. The alignment and orientation of these films were analysed using Grazing Incidence Wide-Angle X-ray Scattering (GIWAXS) and SAXS techniques. R spectroscopy provided insights into the chemical environment, particularly upon azobenzene infiltration, which enabled light-triggered structural transformations. Additional characterisation methods, including Brunauer–Emmett–Teller (BET) surface area analysis, Quartz Crystal Microbalance (QCM), and Scanning Electron Microscopy (SEM), confirmed porosity and guest molecule uptake. This interdisciplinary approach facilitated comprehensive material characterisation and strengthened collaborations within CERIC partner institutions.

3

Nurturing Talent and Public Engagement

CERIC is dedicated to advancing scientific excellence by providing comprehensive training and professional development for scientific and technical personnel.
This chapter highlights CERIC's commitment to nurturing talent, enhancing collaborative training efforts, and inspiring the next generation of STEM students through various initiatives and partnerships. These efforts include training programmes, staff exchanges, PhD scholarships, and educational projects, all designed to enhance skills, build competencies, and support the professional growth of researchers and technical and support staff.

CERIC also aims to ensure an efficient internal and external communication, coordinating promotion, outreach and marketing activities. In this respect, this chapter showcases some of the activities carried out to disseminate scientific results to the scientific community, the industrial environment, the general public and policy makers.

Main Achievements in 2024

1. **~600 hours of training delivered to CERIC staff.**
2. **Contribution to the capacity building of RI staff.**
3. **+70 members of the CERIC community gathered at Science@CERIC 2024.**
4. **80 high-school pupils trained in the frame of the PaGES 8 project.**
5. **9 CERIC-supported PhD project completed.**
6. **Host one professional from the University of Gdańsk seconded to CERIC in the frame of the ERA-Shuttle project to act as university-industry liaison.**
7. **~900 people engaged via science dissemination events: Trieste Next, EU Researchers' Night, ESOF 2024.**

Upskilling staff at CERIC and beyond

HR development of the CERIC staff operating at the Seat

Throughout the year, CERIC has been continuously focusing on the training and professional development of its staff and managers, embracing a philosophy of lifelong learning. In 2024, the CERIC team invested nearly 600 hours in training sessions designed to enhance their skills across a variety of areas, including research data policy and stewardship, software architecture also deploying AI technology, risk management and GDPR, project management and RI funding, impact assessment, gender equality, social media management and public engagement.
CERIC also engaged a professional coach to refine the leadership abilities of its management team.

Capacity building of staff at Research Infrastructures

The investments in the staff training results in very high competencies of CERIC's staff, which are recognised Europe-wide. CERIC's Chief Administrative Officer, Andrea Santelli was invited by the University Milano Bicocca to train the participants in the Executive Masters in Management of Research Infrastructures in the modules on "Financial Management".

Science@CERIC 2024

In October 2024, CERIC brought together in Lecce directors and researchers from all the CERIC PFs to boost stakeholder interaction on ongoing activities, joint research topics, achievements and future development plans.

The 2024 edition has also been an occasion to celebrate 10 years of scientific excellence supported by CERIC, with the attendance of over twenty CERIC users that, among the last 10 years, have used the techniques and instrumentation available at CERIC's Partner and Associated Facilities for cutting-edge research with high scientific impact. Moreover, fifteen CERIC-supported PhD researchers presented their posters narrating their research.

Overall, more than 70 participants took part in a multidisciplinary discussion covering different scientific topics: from advanced materials to energy, and from cultural heritage conservation to genomics and medicine, also involving representatives of the CERIC bodies (i.e. BoD, GA, ISTAC).

The event was co-funded by the Central European Initiative (CEI), and hosted at the University of Salento's ISUFI College, which, together with the CEntro di Fisica Applicata, DAtazione e Diagnostica (CEDAD) constitutes a CERIC AF.

Training pupils and early-stage researchers

Training high-school pupils. The PaGES 8 project

The eighth edition of the PaGES project (Planning, Management and Implementation of a scientific experiment in an international RI) took place in 2024, with the primary aim of familiarising young high-school pupils with the essential skills needed to design, manage, execute, and disseminate the findings of a research project. Throughout the years, the programme has been combining lectures, virtual tours, and hands-on sessions in a research setting, enabling students to make informed decisions about their future studies and careers. This approach bridges educational phases, fostering lifelong guidance and partnership with the corporate sector.

Figure 27
Public event organised by pupils in one of the schools involved in the PaGES8 project, to present the project's outcomes to their fellows.

In 2024, the project received funding from the Friuli Venezia Giulia regional authority. This edition involved four scientific high schools and 80 students, for a total of 18 training hours per school. The goal was to enhance pupils' understanding of the basic principles and applications of various synchrotron techniques available at CERIC, such as microfabrication and lithography, and Raman and infrared spectroscopy.

As usual at the end of the project, pupils presented their experience, and the scientific experiment they carried out at the synchrotron facility in Italy, to a wider audience (nearly 350 people) composed of their fellow students and teachers.

Three researchers from CERIC, as well as from the Italian and Austrian PFs, were involved in training activities, together with two members of the CERIC staff who focused on project management and science communication.

More than 3/4 of the participants (76%) stated that the project contributed to increasing their interest in scientific topics. Furthermore, among the students who currently declare themselves inclined to follow a course of study in the STEM fields (biology, physics, chemistry, mathematics, engineering, etc.), over 66% stated that PaGES significantly contributed to confirming their choice.

Training PhD students

Starting in 2020, CERIC has provided nineteen PhD scholarships for doctoral programmes in collaboration with thirty institutions: eight CERIC PFs and two AFs, and twenty universities and RIs in Italy and around Europe. Eight projects are in the Life Sciences domain, five in Energy Research, three in Materials Sciences, and three in other disciplines.

As at the end of 2024, nine researchers completed their doctoral programme - six in the Life Sciences domain, and the other three in the domains of Energy Research, Cultural Heritage and Materials Sciences, respectively - whereas the others are expected to defend their PhD thesis by the end of 2025.

Throughout the year, researchers also had the opportunity to present their research in twelve workshops and events targeting either the scientific community, or the general public. Moreover, on the basis of the feedback collected from PhD grantees, twenty papers have been published in 2024 in peer-reviewed scientific journals, and more are expected to come in the following years.

Promoting talent circulation in the ERA

Horizon Europe project ERA Shuttle - Accelerating ERA by Sharing Unique Talents for healThy Life and Environment

Aligned with its mission to promote and coordinate the joint training of scientific and technical personnel and young researchers, CERIC has partnered in the Horizon Europe ERAShuttle project.

The project's main goal is to foster R&I capacity in the ERA to benefit the participating Widening Countries: Poland, Croatia, and Malta. This will be achieved by enhancing research and innovation (R&I) support structures, fostering cross-sectoral collaboration, and implementing initiatives for knowledge valorisation and talent circulation. Additionally, the project seeks to increase the attractiveness of regional R&I ecosystems.

During 2024, exchanges with home institutions in the widening countries commenced. As part of this effort, Monika Adamczuk from the University of Gdańsk undertook a secondment at CERIC to act as a university-industry liaison. Moreover, study visits to enhance the capacity of institutions and regions to attract cross-sectoral talent have been carried out, targeting R&I support staff and structures of Widening Countries partner in the project. In this context, CERIC's Industrial Liaison Senior Officer was invited to the ERA-Shuttle Adlershof study visit to give a presentation and participate in the open discussion on fostering innovation ecosystems in the Southern or Eastern European context.

Public Engagement Activities

CERIC's contribution to Trieste Next 2024

In 2024, CERIC also contributed to the science dissemination event that every year, in September, takes place in Trieste: the festival of scientific research, Trieste Next.

This event is a showcase for innovation and applied research where researchers and entrepreneurs present their experiences and tell how, thanks to the technological transfer of cutting-edge research, new solutions can be created. The 2024 edition - promoted by the Municipality of Trieste, the University of Trieste, ItalyPost, Area Science Park, OGS and SISSA - was entitled “The horizons of knowledge. Between human beings and technologies”.

In collaboration with Elettra, CERIC organised two conferences involving some of its PhD grantees and researchers, and addressing lay publics and science enthusiasts:

- *When physics goes to the ward,* with Giulia Saccomano and Lorenzo D’Amico
- *New, smart materials for carbon storage*, with Benedetta Marmiroli, Sumea Klokic, and Giovanni Birarda.

Both conferences reached full room occupancy, with a total of more than 100 participants. The conferences were also broadcasted live via a streaming service.

European Researchers Night 2024

In 2024, CERIC contributed to the European Researchers Night in Trieste, in collaboration with Elettra, offering young students the opportunity to visit the synchrotron and carry out a real scientific experiment.

After a brief introduction on the history and functioning of the synchrotron, guided by researchers from Elettra and CERIC, pupils prepared samples using the (micro)lithography method, and then analysed them with Raman spectroscopy, a sophisticated technique for investigating matter.

The goal was to help participants discover what it means to be a researcher and test their individual skills related to research work.

Figure 28
Participants in the European Researchers Night 2024 edition at Elettra Sincrotrone Trieste.

CERIC at ESOF 2024

For the fourth time, CERIC actively participated in the 2024 edition of the European Science Open Forum - ESOF, which was held in the city of Katowice - Poland. The event is designed to offer the scientific community a platform for interdisciplinary and intersectional debate about scientific culture, research, and innovation.

In its 2024 edition, ESOF was organised into six thematic areas, which reflect the commitment of the scientific community to address some major societal challenges: energy transition, sustainable environment, cultural identity and societal transformation, changes within scientific excellence, healthy society and digital transformation.

Figure 29
CERIC panel at ESOF 2024 in Katowice.

CERIC contributed with a talk presenting some studies in the field of energy research, performed in some of its PFs, with particular emphasis of the use of synchrotron radiation to test and develop more efficient and long-lasting batteries.
The talk included contributions by Giuliana Aquilanti, from the CERIC PF at Elettra, and Alexey Maximenko, from the Polish PF at the SOLARIS National Synchrotron Radiation Centre.

Participation in the PAERI Conference 2024

Ever since it was first set up in 2015, CERIC has been member of the ERF-AISBL - European-level Research Infrastructure Facility association's working group (WG) PAERI - The Public Awareness and Engagement with Research Infrastructures (PAERI). This WG was established to collect requirements and best practices in the areas of public relation, communication, and public awareness from the member infrastructures, to then provide advice and good practices for ERF AISBL members on activities and future development.

In this framework, the WG organises a biannual conference gathering communication and public engagement professionals across RIs in Europe, to share best practices and discuss on common challenges in the RIs' communication and public relation domain.

In the 2024 edition of the conference, CERIC science communication officer, Marcello Turconi, contributed to the event with the presentation *CERIC: a case study of science communication in a distributed RI*. The speech was an opportunity to show some of the strategies implemented by CERIC in science communication, as well as to exchange visions, experiences and solutions with other science communication specialists working in different research organisations.

4

Cultivating Innovation and Industry Cooperation

Among CERIC's objectives is economic activity through the collaboration of its facilities with industry. To this end, an industrial liaison office (ILO) has been set up.
The aim of the industrial liaison activities is to improve the collaboration of CERIC PFs with industry, building on the strength of its partnership. The long-term goal is to contribute to Europe's innovation potential by positioning itself as a major resource in the field of advanced materials, which, as a key enabling technology, affects the performance of both industrial and technological strategic sectors, such as energy and life sciences.
The rationale behind the objective is the economic prosperity of Europe, to which also RIs, albeit primarily established to enable scientific research, should contribute by:

- Developing innovative solutions and technology transfer.
- Raising awareness among the industry about RI's potential and solutions.
- Enabling excellent research through access to the excellent facilities usually not available for industry.
- Creating and stimulating industry innovation potential and increasing its performance, providing state-of-the-art knowledge to the industry.
- Aligning the knowledge and potential of RIs with innovation needs from the industry by collecting and mapping its innovation needs.

Main Achievements in 2024

1. **Promotion of the CERIC services for the industry at major events: EIC Summit, VIVATECH, Re-Battery 2024, European Hydrogen Week.**
2. **Engagement with ~100 industrial stakeholder in a workshop organised at the BSBF 2024, with a focus on industrial and policy challenges in hydrogen research.**
3. **New ongoing negotiations with the companies in the energy and pharma sector for commercial access to CERIC facilities.**
4. **10% of the articles from open access research related to industry.**

Industrial Liaison Activities

In 2024, CERIC continued to strengthen the European innovation ecosystem, involving both public and private stakeholders and creating opportunities to increase the consortium's impact on industry. CERIC has participated in the EIC Summit as an EIC Partner advocating the importance of RIs as key partners in achieving European innovation goals. Thanks to the partnership with the EIC, CERIC was also able to participate in VIVATECH - Viva Technology, Europe's largest annual technology event dedicated to start-ups and one of the most important in the world. During this event, the Consortium services were presented to some of the EIC Beneficiaries.

The continuous promotion of the services and capabilities of the PFs to industrial users has been carried out through the participation in relevant research to business events, such as Re-Battery 2024 - the largest international trade fair in Southern Europe within E-TECH EUROPE 2025. Moreover, as part of the RE-Made project, CERIC attended Chemical Recycling Europe, an event focused on exploring the ongoing developments as well as the challenges and opportunities for the industry, bringing together experts from across the supply chain. Finally, CERIC also participated to the European Hydrogen Week with a stand in the area dedicated to Hydrogen Europe Research, of which CERIC is a member.

In October 2024, in collaboration with Area Science Park, an international workshop was organised as part of the Big Science Business Forum - a business-oriented congress focused on high technology and innovation, which aims to be the main meeting point between RIs and industry in Europe. Specifically dedicated to hydrogen research and industrial and policy challenges in the hydrogen value chain, the workshop provided a unique opportunity to discuss, through a series of presentations and roundtables, technological and scientific developments, the policies needed to support the sector value chain, and the key aspects for innovation and success of hydrogen in industry.

Thanks to the activities carried out, feasibility tests have been carried out with a company in 2024 involving three of the CERIC PFs, demonstrating the importance of a multi-technique approach and paving the way for a commercial agreement with the company. Negotiations are also underway with another company in the energy sector, for a future collaboration involving two PFs.
Additionally, CERIC introduced a new company to Elettra and faciliated the signing of a commercial agreement related to the pharmaceutical sector.

As for industrial usage of CERIC PFs via open access in 2024, 2% of total accesses were related to industry-linked projects. Regarding publications, 10% of articles released in 2024 were industry-related, accounting for publications with company-affiliated authors, or those connected to industry proposals.

5

Other EU Priorities and Impact

As an entity established by the European Commission, CERIC should contribute to the development of the ERA.

CERIC's contribution to this objective is presented in this chapter.

Main Achievements in 2024

1. **First draft of the CERIC impact assessment report produced.**
2. **Report on the impact of CERIC in Austria presented during the visit to the CERIC premises, of the Austrian Federal Minister for Education, Science, and Research**
3. **Preparatory work towards a European employment contract.**
4. **Contribution to ERIC Forum D12.1 released in spring 2024, and to be used by the EC for the revision of the ERIC practical guidelines.**

CERIC impact assessment in progress

Established a decade ago, CERIC has been influencing science, economy, and society ever since. The evidence underscores a wide array of impacts across CERIC Member Countries. Notably, as many of these are widening countries, the Consortium plays a crucial role in reducing the research and innovation gap within Europe.

The methodology used to define CERIC's impact was designed to outline CERIc's activities and assess their effect. Four dimensions on which the activities of the Consortium can have an impact have been taken into account:

- Science
- Innovation
- Society (including contribution to the ERA)
- Human Resources

Key Impacts

Enabling Scientific Excellence

Over the past nine years (2015-2024), research performed within CERIC - be it by users or through internal research - has resulted in the publication of 715 peer-reviewed scientific publications spanning a wide range of domains (Figure 30):

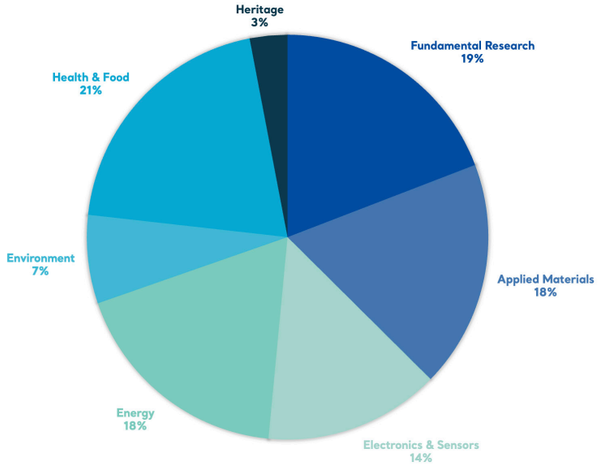


Figure 30
Share of publications per domain.

Moreover, quite a number of CERIC scientific papers are among the top 10% most cited in the world in a particular field of research. In the latest nine years, on average 9% of articles were in such a category every year (Figure 31), in research topics spanning applied materials (26%), electronics & sensors (14%), energy (16%), and health (23%).

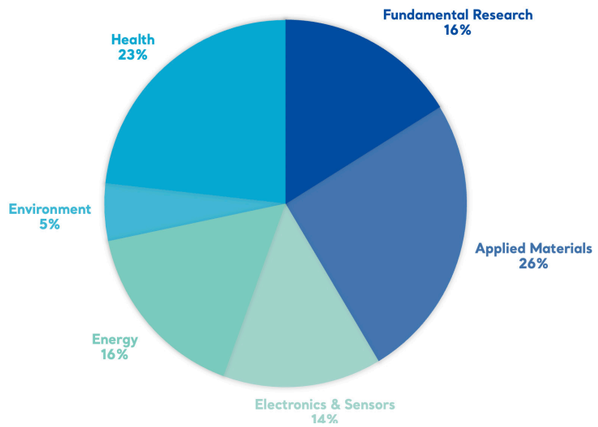


Figure 31
Share of CERIC Top 10% papers per domain.

Analysing the top 10% of most cited articles provides valuable insights into the forefront of scientific research performed at CERIC. This information may feed into future decisions on resource allocation, foster collaboration, and ultimately drive innovation across various fields.

Economic Growth Stimulated by Deep-Tech Innovations

Although established primarily to enable scientific excellence, CERIC boosts economic growth by fostering deep-tech innovations. These technologies, grounded in cutting-edge scientific research, have far-reaching impacts across multiple industries. 10% percent of CERIC's publications in 2024 have industry involvement, be it announced during the proposal submission (5%) or co-authoring publications (5%). Furthermore, in the period 2015-2023, 17% of CERIC's articles have first or second-degree patent citations[26], which is a good indicator of the impact of CERIC activity on economic growth, as the results protected by patents are the ones related to innovations that can have a better potential to be applied and taken up by the market.

Impact on CERIC's Member Countries

Although CERIC is open to the global research community, data shows that it is of particular and growing relevance for researchers from its Member Countries, as shown by:

- **Increased scientific productivity.** CERIC brings high-quality users to its PFs, as shown by the increased number of peer-reviewed scientific articles published: the review of the Slovenian PF by CERIC's ISTAC in 2021 reported that the number of papers per unit usage time is doubled through CERIC's open access, demonstrating its benefits on the productivity of the PF.
- **Strengthened internal research.** CERIC PFs report that being part of the Consortium has enabled their scientists and PhD students to support diverse users across a variety of experiments and research topics, thus enhancing the overall knowledge and capacity of the national scientific communities.
- **Technological innovation.** The Czech PF reported that the CERIC-funded project CEROP, which involved developing a new sample preparation system/sample holder in collaboration with other facilities, has improved user performance by integrating it into the PF's instrumentation. Another example is the creation of the graphene cell for IR experiments, also supported through CERIC internal research. According to the Austrian PF Director, these technological innovations have enhanced the PF capacities, providing a competitive edge over similar facilities in other countries. while also demonstrating how CERIC plays a key integrating role across its PFs.
- **Expanded research networks**. Excellent external users aid in facilitating the integration of the PFs into EU-wide networks. As an example, through international calls CERIC has attracted in 2024 researchers from 37 countries., This global collaboration boosts scientific output, strengthens integration in EU networks, and provides valuable knowledge for local researchers.

[26]First-degree citations: articles cited directly in patents. Second-degree citations: patents citing CERIC citing articles.

- **Increased scientific quality.** CERIC contributes to increasing the scientific quality of analytical facilities in different countries. The data for Romanian PF shows that the IF and the Article Influence Score (AIS) of the articles derived from CERIC Open Access are higher compared to the articles published outside CERIC, with an average AIS of 1.5 (vs. 0.8 in RO research) and an IF of 8.65 (vs. 5.12 in RO research). This kind of data demonstrates how CERIC contributes to a reduction of the R&I gap for this Widening Country. As another example, the Hungarian scientific community clearly benefits from the various techniques offered through CERIC: 93% of Hungarian researchers requesting access to CERIC PFs have applied for a technique from another CERIC country in the period 2020-2023. This gives the Hungarian community access to cutting-edge facilities, that would have been difficult to obtain otherwise, supporting Hungarian scientific excellence.
- **Increased participation in EU projects.** As a European RI, CERIC has the eligibility conditions, critical mass, and visibility to participate with its PFs in some EU-funded projects. An example is the Italian PF, which has benefited from its participation in the cluster project PaNOSC - Photon and Neutron Open Science Cloud, which was limited to EU RIs. The Croatian PF was invited to take part in the project RADIATE, helped by the international open access experiences gained through CERIC.

Integrated Research and Innovation Ecosystem Across Europe

Due to its critical mass of instrumentation, competencies, and knowledge, CERIC shall play an important role in creating a more cohesive R&I ecosystem in Europe by facilitating strategic cooperation among national, regional, and local entities and the research facilities they support. This integration helps overcome European fragmentation in research efforts, impacting also the innovation dimension. The network outcome is evidenced by the increased interconnections among CERIC facilities, which boost innovation through shared initiatives and collaborative projects, and the participation in European projects.

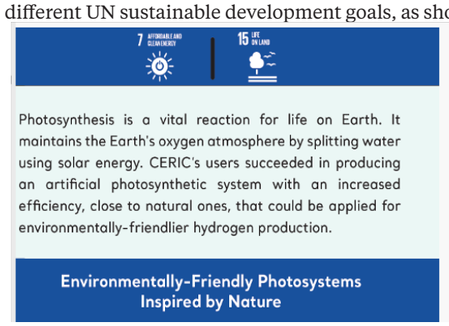
The consortium's strategic partnerships also contribute to this impact. CERIC is the only European RI which is a member of Hydrogen Europe Research (HER) and one of the few, which partnered with the European Innovation Council (EIC). Through the partnership with the EIC, CERIC can provide specific services to the EIC beneficiaries. CERIC is currently actively promoting its services to this innovative community.

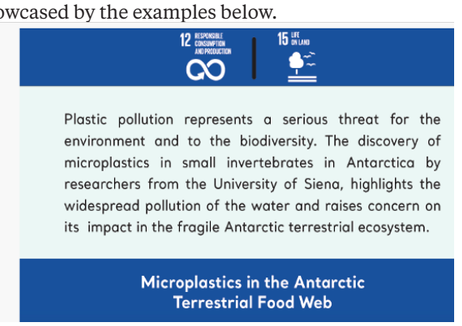
Societal Benefits

Innovations stemming from CERIC's research help address critical challenges, from healthcare to environmental sustainability. This is evidenced by the citations of CERIC's articles in patents (1st degree), where half of them is related to the health domain. The articles share a common focus on the development and application of advanced materials for biomedicine, particularly in drug and gene delivery systems, and cancer therapy. They emphasise the use of innovative nanocarriers and functional coatings to enhance therapeutic efficacy and specificity.

In addition, in the period 2015-2023, 106 of CERIC articles have at least one 2nd degree patent citation and they mainly focus on energy, electronics and health & food. Energy is the one with most citations, in particular in the fields of hydrogen and batteries, confirming CERIC's strategic focus on these two domains.

Moreover, CERIC research projects provide ground-breaking discoveries that largely contribute to different UN sustainable development goals, as showcased by the examples below.





Visit of the Austrian Minister of Education, Science, and Research at CERIC

On May 13th, 2024, a delegation led by the Austrian Federal Minister for Education, Science, and Research, **Prof. Dr. Martin Polaschek**, visited the premises of CERIC in Trieste. Joined by representatives from the Ministry and the Graz University of Technology (TU Graz), the delegation had the chance to learn more about the endeavours undertaken within CERIC, with a particular focus on the collaborative efforts involving Austria, the Czech Republic and Italy, at the CERIC Italian PF.

Figure 32
Minister Polaschek (on the right) with Heinz Amenitsch at the Austrian Small-Angle X-ray Scattering synchrotron beamline.

During the visit, Minister Polaschek and his delegation were provided with detailed insights into the operations of CERIC, emphasising Austria's contributions through two synchrotron beamlines in Trieste and a laboratory at the Technical University Graz. The cutting-edge techniques, which are fully accessible to CERIC users and complementary to the over 60 techniques in the CERIC portfolio, offer invaluable capabilities in the examination of nanoscale structures of diverse materials and the fabrication of microdevices allowing the manipulation and analysis of nano-sized objects.

The visit of Minister Polaschek underlined the enduring spirit of collaboration and innovation fostered by CERIC, as it continues to drive transformative research initiatives on a regional and international scale.

Notably, Austria's leadership in the formative stages of CERIC, through the coordination of the Salzburg working group, laid the groundwork for the Consortium's establishment in 2014. This collaborative initiative, which brought together ministers from CERIC Member Countries, reflects a commitment to fostering scientific cooperation and innovation across borders.
Furthermore, in the Salzburg working group, Italy was represented by the region Friuli Venezia Giulia for the specific international activities that the Region carries out with Eastern European countries.
In this framework, also the Central European Initiative (CEI), with which CERIC keeps collaborating throughout the years, has been a key actor. This collaboration continues to enrich scientific endeavours and promote cross-border cooperation in the pursuit of scientific excellence.

In the following section, the key impact of Austrian participation in CERIC is presented.

CERIC's impact in Austria

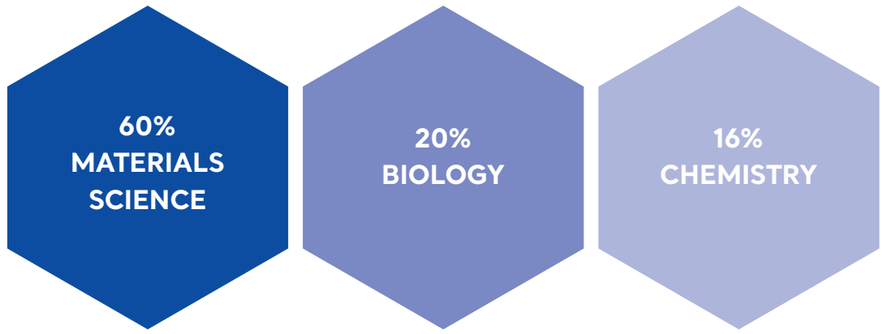
The CERIC Austrian PF has contributed to several impacts since CERIC was set up, and specifically:

- Enhanced RI and HR Investments.
- Boosted scientific output and enhancing international collaboration.
- Strengthened Engagement of the Austrian User Community.
- Advanced Scientific Research.
- Leveraged Economic and Industrial Potential through, among others, Energy and Life Sciences Research.

Through CERIC, excellent global users have been attracted, selected and given access to the Austrian PF instruments and competences. This has led to high-quality publications and has contributed to the integration of the facility in the European networks, increasing the proposals to EU projects and industry use. It has also allowed the PF staff to be informed of the leading research lines and to discuss improvements in the techniques and technologies.

Austrian participation in CERIC has been contributing to boosting scientific excellence, further expansion of networks of Austrian researchers, and to providing valuable knowledge for local researchers.

The Scattering techniques offered by the Austrian PF are used across different domains of science. Below are the proposals received since 2014 divided by discipline:



CERIC has also been promoting the relationship between industry and the Austrian PF also to enhance the economic impact of its research and capabilities.
This trend, coupled with the successful patent application for metal-organic framework biocomposites by TU Graz, points to the importance of the activities of the Austrian PF at CERIC in driving industrial innovation and suggests further investment in such promising fields, particularly in gas storage and separation technologies, which are experiencing significant market growth due to increasing demand.

Towards a European Employment Contract

In the frame of the Second Implementation Project of the ERIC Forum, CERIC has been contributing to a work package (WP11) aimed at identifying the main issues in developing attractive careers for researchers and personnel in support of research activities in the ERICs, as well as at developing a proposal for a common legal framework to be presented at EU level.

Throughout 2024, current practices of employment contracts in the European context have been analysed, both at international organisations based in Europe, and at the ERICs. The results pave the way to the later delivery of a draft proposal for the key elements to be embedded in a potential common European employment contract for the ERICs.

The implemented tasks included the following actions:

- **A specific review of the relevant outcomes coming from completed projects** (e.g., ERIC Forum 1, and ACCELERATE), which gave useful indications regarding some of the solutions adopted by the ERICs according to the existing legal framework, and about topics that were not solved at the time, and that and in many cases remain still unsolved. The review also included the RITrain Project and the possibilities it opened to provide personnel of the ERIC with specific training, and to identify career paths.
- **An analysis of the key elements of unified employment contracts in international organisations in Europe.** Specifically, four organisations - EMBL, ESA, ESO, European Joint Undertakings - whose employment contracts were publicly available, were selected and studied.
- **A detailed survey submitted to all ERICs, to identify the main issues related to the current solution of employment contracts based on national legislation**. The survey allowed gathering information on the legal and economic treatment of researchers and research support personnel in ERICs (technicians and managerial staff, including administrative, communication, legal, HR management, as well as other emerging professionals) in European countries, according to national legislations, thus providing a complete and updated description of the situation in 23 ERICs.

Three different case studies were then collected, related to the management of personnel in the ERICs. These use cases reflect, with examples, some situations that ERICs face, and the related difficulties. The purpose has been to understand in practical terms what kind of issues ERICs have been facing, and the solutions they eventually adopted, and to inform other ERICs, in the form of "lessons learnt", on the kinds of issues they could face as a consequence of specific choices.

All the information collected and elaborated has been included in the project deliverable D11.1 - Employment regulations applied to researchers and support staff in different Countries - which has been submitted in early 2025.

Improving the implementation of the ERIC Regulation

Since the establishment of the Regulation on a Community legal framework for ERICs in 2009, the ERIC regulation has served as a cornerstone for the setup of an ERIC and other European non-ERICs. The ERIC concept has played a pivotal role in implementing the ERA, providing a clear legal framework for governance, operations, and scientific endeavours. Over the years, the ERIC regulation has enabled collaboration among Member States, reduced duplication of efforts, and enhanced coordination in research and innovation.

However, despite its significance, the implementation of the ERIC regulation has encountered challenges, which relate to evolving interpretations of the regulation. From governance and financial sustainability to varying national laws and VAT exemptions, ERICs have navigated through complex landscapes, each presenting its own set of hurdles.

The Second Implementation Project of the ERIC Forum has addressed these challenges by establishing an internal team tasked with detailing the critical issues related to the implementation of the ERIC Regulation from an operational point of view and creating a list of recommendations on how to address them.

Also with the contribution of CERIC, the project deliverable D12.1 - Recommendations on how to address the challenges related to the ERIC Regulation and its implementation for the relevant WPs of ERIC Forum 2, that is particularly useful for raising awareness on the current challenges for those in the process of setting-up an ERIC - was then released in spring 2024, to be used also by the European Commission for the revision of the ERIC practical guidelines.

The deliverable includes seven sections, each one focusing on a different area, the associated challenges and recommendations to address them:

1. Governance and organisational matters.
2. Financial sustainability.
3. ERIC status in host countries, with an overview of the varying national laws and contexts that entail hurdles for the ERIC recognition.
4. Implementation of the VAT exemptions.
5. Limited economic activity
6. Human resources, including the issue of mobility and employment of highly skilled personnel.
7. International outreach

As stated in an interview with Luc van Dyck from Euro-Argo ERIC[28], *the main problems identified don't lie in the spirit of the regulation, and rather in the various interpretations that have been made of it and in the implementation at national level. In part, it can be traced back to the lack of clear, operation-based guidelines, especially in the early days. But in many instances, challenges may relate to a too-weak political commitment of some member states for the ERICs in which they participate. At governance level, members may fail to exercise their due political oversight. At financial level, ERICs are chronically understaffed and under-resourced. Challenges related to the ERIC status in the host country, notably the fiscal status, or the operationalisation of the VAT exemption deserve more attention and necessitate a sustained dialogue between different national administrations. All this is but a part of what is addressed in the paper, which would constitute a precious resource for both existing ERICs and ERICs-to be.*

[28]https://www.eric-forum.eu/2024/07/18/how-to-address-the-challenges-related-to-the-eric-regulation-and-its-implementation/

6

Operations and Finance

Main Achievements in 2024

1. **Update of the CERIC Internal Rules of Procedure.**
2. **New CERIC Executive Director appointed.**
3. **Development of the CERIC's Proposal Management System began in 2024.**
4. **Financial and in-kind annual account.**

CERIC Internal Rules of Procedure

CERIC has been operating and evolving for more than ten years, and its operations have also been evolving from initially focusing only on access by external users to launching and supporting research projects aiming to integrate more effectively the multidisciplinary capabilities of its PFs. This implements the original aim of setting up CERIC as an integrated RI operating in Central Eastern Europe, as it is defined in its Statutes. The setting up of AFs and the start of annual financial contributions by the Members of CERIC aim to increase its outreach and consolidate the integration.

The day-to-day operations are framed by a set of Internal Rules of Procedure which detail and facilitate the implementation of the Statutes. These Rules need to reflect better the experience accumulated so far while allowing for a more effective integration. This has required updating them. A working group of the GA Delegates from the Member's Ministries is involved in this effort with the chair of the GA, and the next GA will have a dedicated discussion on these aspects.

New CERIC Executive Director appointed

Following the decision of the CERIC GA in June 2024, the Consortium appointed Professor Andrew Harrison as its new Executive Director, effective from December 2024.

'I am looking forward to building on the achievements of CERIC under the leadership of Jana Kolar, pioneering open access to multiple techniques across a collection of RIs to address complex scientific and societal challenges. CERIC's Facilities have already had a marked impact on science and innovation, but there are many opportunities still to explore, from the life sciences and biotechnology to energy or quantum materials, through strengthening the collective capabilities of their instrumentation, and their engagement with the research community, particularly in Central Europe'. – Harrison stated.

Professor Harrison brings a wealth of expertise in managing and advancing world-class RIs, particularly user-focused facilities.
From 2022 to 2024, he served as Director of Science at the Extreme Light Infrastructure, where he played a pivotal role in developing its user access programme. Before that (2013-2022), he successfully led the Diamond Light Source, overseeing its transition from construction to full operations, while developing a strategy for long-term sustainability and achieving significant growth in its user base.

Prior to that he was a prolific user of RIs for neutrons and synchrotron X-rays as a materials chemist at the Universities of Oxford and Edinburgh, and from 2006 to 2013, he served as Associate Director for Science then Director General at the Institut Laue-Langevin in Grenoble, France - a globally renowned neutron science facility.

Prof. Harrison has also made substantial contributions to European and international scientific policy. He chaired both EIROForum (2012-2013) and the ERF AISBL (2017-), gathering Europe's leading RIs beyond the EIROForum network. As the UK delegate to ESFRI (European Strategy Forum for Research Infrastructures) 2014-2019, he has played a key role in shaping policies and the evaluation framework for European RIs.

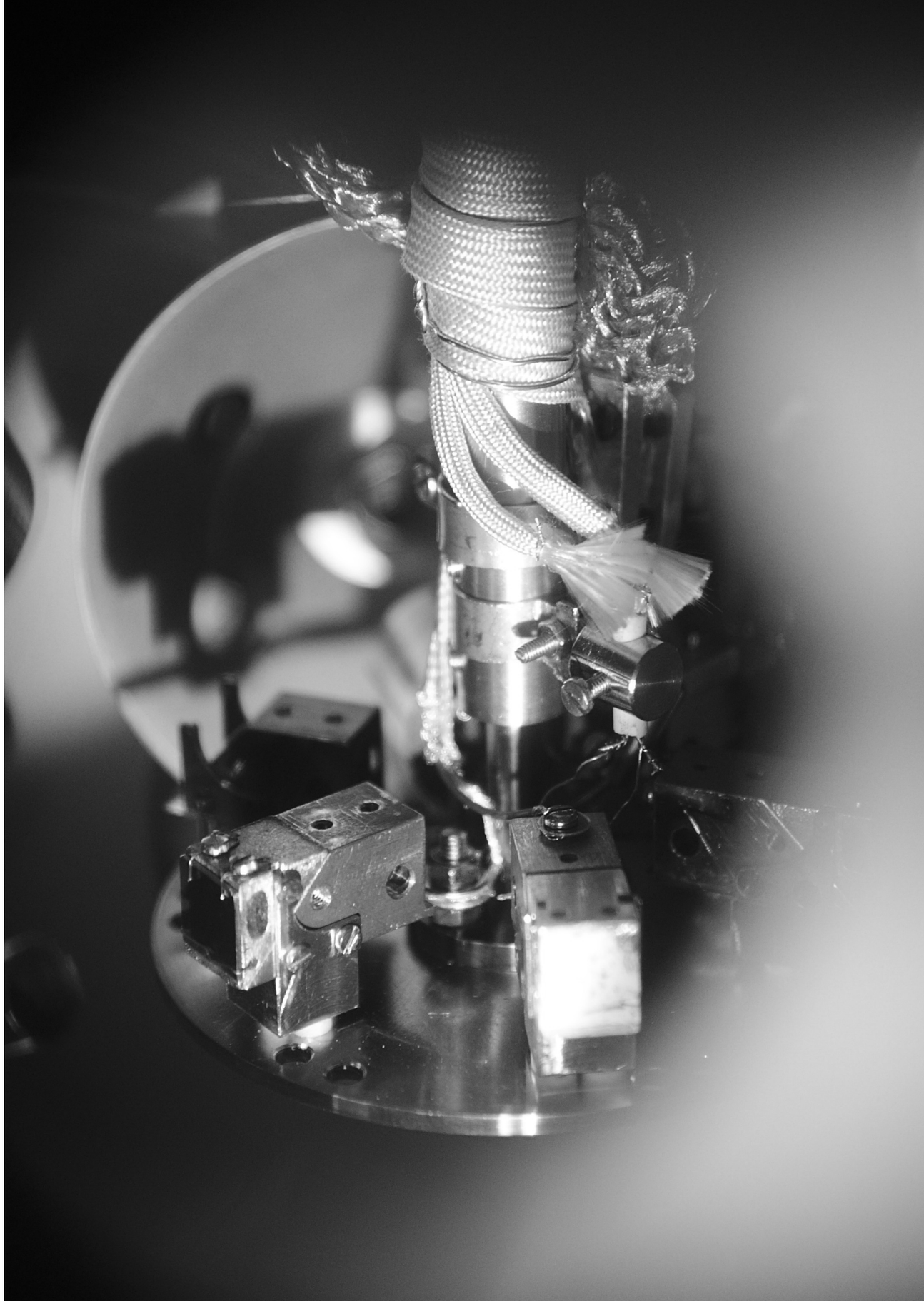
Throughout his distinguished career, Prof. Harrison has been a driving force in enhancing the research landscape across Europe, fostering scientific excellence, and building impactful partnerships with diverse stakeholders.

CERIC is confident that Prof. Harrison's leadership will steer the consortium towards strengthening further its position as a distributed infrastructure of cutting-edge research and innovation.

CERIC's Proposal Management System

The Proposal Management System (PMS) is a web portal - comprising a collection of web applications - that allows users to manage the entire lifecycle of their applications for access to the scientific instruments offered by the CERIC consortium. It also supports users in fulfilling the obligations associated with the use of these instruments. The PMS serves as the main entry point for users accessing CERIC's distributed RI and is responsible for managing a significant part of the user journey.

Development of the new software began in early 2024, using a modern technology stack and a fresh approach. In December 2024, the CERIC IT staff released an initial Alpha version of the PMS, which includes some core features of the system. A sandbox environment is also available for collecting feedback and conducting internal testing.



Financial Statements 2024

The financial statements give the details of the additional expenditure for the organisation, coordination and governance activities of the Consortium, which contribute to increase the effectiveness of the much larger in-kind contributions by the CERIC's member countries through the PFs.

The financial statements are compiled in conformity with the IPSAS - International Public Sector Accounting Standards issued by the International Public Sector Accounting Standard Board (IPSASB).

Balance Sheet - Assets and Liabilities	2024	2023
ASSETS	**8,882,464.67**	**8,584,072.52**
Non-current Assets	**2,971,382.57**	**1,417,294.87**
Plant, property and equipment	2,933,081.95	1,397,566.25
Intangible assets	38,300.62	19,728.62
Investments in associates	-	-
Current Assets	**5,911,082.10**	**7,166,777.65**
Inventories	-	-
Long-term credits	-	-
Short-term credits	90,313.88	135,987.35
Other current credits and receivables	-	-
Cash and cash equivalents	5,805,703.30	6,875,385.68
Prepayments and accrued income	15,064.92	155,404.62
EQUITY AND LIABILITIES	**8,882,464.67**	**8,584,072.52**
Equity	**-**	**-**
Equity	-	-
Capital and other permanent contributions from Members	-	-
Reserves	-	-
Accumulated profits	-	-
Non-current Liabilities	**529,174.56**	**516,633.99**
Long-term financial debts and loans	-	-
Other long-term debts and liabilities	-	-
Advance payments for externally funded projects	243,719.57	294,293.43
Pensions funds and other benefits for compensation employment	285,454.99	222,340.56
Long-term provisions	-	-
Current Liabilities	**8,353,290.11**	**8,067,438.53**
Short-term financial debts	-	-
Other short-term debts and liabilities	344,959.58	295,478.72
Advance payments for externally funded projects	347,651.50	254,789.52
Other current payables	279,575.98	274,684.21
Contingent liabilities	40,783.62	40,783.62
Deferred income and accrued expenses	7,340,319.43	7,201,702.46

Profit and loss account		2024	2023
Revenues		**3,464,387.45**	**2,927,480.77**
	National and international grants and contributions	3,457,605.84	2,922,363.29
	Contributions in-kind	-	-
Other revenues	Other revenues	6,781.61	5,117.48
Operating costs		**2,828,671.63**	**2,423,102.14**
	Costs for raw materials, supplies and goods	17,417.03	3,437.71
	Costs for services	908,260.90	956,158.83
	Resources committed in-kind to CERIC from contributors	-	-
	Staff costs	1,861,416.47	1,446,405.27
	Costs of rents, concessions and royalties for trademarks	610.00	-
Other operating costs	Costs for institutional activities	40,967.23	17,100.33
Ebitda (Earnings before Interest, Taxes, Depreciations and Amortizations)		**635,715.82**	**504,378.63**
Depreciation		708,048.73	474,413.51
Write-downs for impairment of tangible and intangible assets		-	-
Ebit (Earnings before interest and taxes)		**-72,332.91**	**29,965.12**
Financial income and expenses		**116,936.91**	**7,212.88**
	Financial income	117,046.58	7,485.10
	Financial charges	-109.67	7,485.10
Income from investments		-	-
Value adjustments to financial assets		-	-
Result before tax		44,604.00	37,178.00
Taxes		44,604.00	37,178.00
Result for the year		**-**	**-**

Additional information is provided in Annex 1 (Notes to the Financial Statements as at December 31, 2024) in order to explain the assumptions used to prepare the numbers in the financial statements, as well as to better understand the company's financial position.

Annex 1

Notes to the Financial Statment as at December 31st, 2024

Accounting Criteria

These annual Financial Statements have been compiled in conformity with the IPSAS (International Public Sector Accounting Standards) international accounting standards issued by the International Public Sector Accounting Standard Board (IPSASB), and in process of being adopted by the European Commission within the meaning of Council Directive No 2011/85/EU of 8 November 2011, on requirements for budgetary frameworks of the Member States.
The decision voluntarily to adopt an accounting system that can be connected to international principles is consistent with the process of harmonization started some time ago by the EU Commission, but not yet completed.
The IPSAS can in general function as a basis for a harmonised accrual-basis accounting standard passing through its transformation into EPSAS (European Public Sector Accounting Standards). The aforementioned EU Directive states that “by 14 December 2018 the Commission shall make public a review of the sustainability of the Directive (see art.16).
CERIC-ERIC is set up as an international organization with scopes of general interest typical of an entity referable to the public sector. CERIC-ERIC should therefore be able to relate to its Members in different countries in a common language. This should be adopted in all matters and at all levels, and thus also in the model of presentation of economic-financial topics that support annual accounts and budgets.
The use of international accounting standards referable to the public sector, taking-into account the specific character and scopes of CERIC-ERIC, adequately conforming to the legal characteristics of the entity and to its functions and scope, allows the development of well-defined best practices, the impact of which on the financial aspects is measurable and effective. The use of international accounting standards, in fact, allows information on the financial statements to be presented in a common way for users/stakeholders of different nationalities.

It is possible in this way to ensure that:

- The information is relevant, reliable, comparable and understandable;
- The terminology used is common, appropriate and explanatory among Members and for similar international organisations outside Europe;
- The financial statements are auditable by the International Standard of Audit by auditors from different countries;
- A host country change - and thus any site change - is not relevant for the comparability of information and models, books and records of the accounting system;
- The accounting system is able to present the in-kind contribution model, and to provide analytical accounting for projects and separate accounting for economic activities.

The aim of the annual financial statements is to provide information on the assets and liabilities, the profit or loss and changes in the financial structure of the Consortium, useful to a wide range of users. The financial statements are prepared within a general-purpose framework.
The financial statements have been compiled in accordance with the principles of clarity and transparency and provide a correct and exhaustive framework of information on property relations, as well as economic and financial relations implemented by the Consortium in carrying out its activities.
They have been compiled taking-into account international accounting standards for the public sector (IPSAS), where applicable, and integrated in order to be consistent with the legal and effective structure of CERIC.
Of the various options allowed by IPSAS 1, the Consortium has chosen to present the layout of the balance sheet distinguishing between current and non-current items, and the layout of the profit and loss account classifying the expenses by nature.

In its drawing-up, the following principles have been observed:

- The items have been evaluated prudently, taking into account the perspective of the continuity of the activities, as well as the economic function of an asset or liability;
- Only incomes and expenditures related to the financial year have been accounted, independently on the day of encashment or payment;
- The risks and losses related to the financial year have been accounted for, even if known after the end of the financial year.

These Notes have been compiled with the aim of clarifying, completing and detailing the information contained in the balance sheet and in the profit and loss account, in addition to providing information on the applied evaluation criteria, on movements that have taken place, and changes in various assets and liabilities.
The explanatory notes are an integral part of the following documents, to present these financial statements and provide descriptive and schematic information, with particular reference to property aspects, as well as economic and financial aspects of the overall management.

The financial statements comprise the following parts:

- Balance sheet
- Profit and loss account
- Explanatory notes
- Management report
- Reconciliation between final budget and Annual Accounts
- Statement of cash flow
- Trend of the net financial position (NFP)

Evaluation Criteria

The financial statements have been compiled in accordance with the principles of clarity and transparency and provide a correct and exhaustive framework of information on property relations, as well as economic and financial relations implemented by the Consortium in carrying out its activities. They have been compiled taking into account international accounting standards for the public sector (IPSAS), where applicable.

Balance Sheet

Items in the balance sheet are classified into/distinguished as current/non-current.

Assets

Assets have been classified as current assets when:

- They have been realised during the normal operating cycle of the institution;
- They are cash or equivalent complement not restricted in its use.

Assets realisable within the operating cycle have been classified as current, regardless of whether they have actually

been realised within 12 months from the balance sheet date.Non-current assets include tangible assets, intangible assets (licenses and in general all assets not related to the operating cycle and realisable after 12 months from the balance sheet date).

Liabilities

Liabilities have been considered current liabilities when:

a) They are extinct in the course of the normal operating cycle of the institution;
b) Extinction is due within 12 months from the balance sheet date.

Other liabilities, i.e., those not related to the operating cycle and all other institutional liabilities, are classified as current if their extinction is due within 12 months from the balance sheet date.
Otherwise, they are recognised as non-current liabilities.

Deferred Incomes and Accrual Expenses

This item includes the amount of funds received up to December 2024 and not yet fully used by 31.12.2024 for the purposes for which they were intended. They will therefore continue to provide utility in coming years, for the same purposes. This item represents the carry-over for balances of the subsequent year to that under review. In this regard, the Consortium is obliged to operate in future years in fulfilment of the mandate required by the Italian Ministry of Education, University and Scientific Research, who assigned the financial funds (FOE) under which CERIC activities were carried out in 2024, and by the other member states in order to pursue the scopes set in the GA resolution of 29-30.11.2023 approving the budget for 2024.

In-kind Contributions

Contributions in-kind will be included in the financial statements on the basis of the details contained in the document entitled "Methodology for Defining the Values Involved in CERIC-ERIC Activities, and to Detail In-kind Contributions".

In-kind non-monetary contributions will be distinguished (when realised) between:

1) Those strictly related to the cost of the production factors (exhausting their utilities during the ordinary cycle).
2) Those strictly related to covering investments (in intangible and tangible assets).

Profit and Loss Account

The drawing-up of the profit and loss account is regulated by the IPSAS, integrated and conformed to be consistent with the characteristics and scopes of CERIC-ERIC.

Incomes

Incomes are increases of benefits connected to the administrative year.

Costs/Expenses

Costs/expenses are decreases of economic benefits of the administrative year. The analysis of costs has been explained in the overview of profit and loss account using a classification based on their nature.

Assets

Non-current Assets

Tangible Assets

Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
1,397,566.25	2,933,081.95	1,535,515.70

Most of the acquisitions completed during the year refer to the investment in capital equipment linked to the research projects INTEGRA, BATTERIES PLAN and EOI call for proposal; the residual part refers to supplies for the central seat.

The following flow chart shows the change in individual items summarised in the present note.

Description	Property	Technical furniture	Electronic office machines	Office furniture	Mobile phone	Equipment in progress	Total
Balance as at 31/12/2023	**-**	**1,233,503.91**	**19,578.59**	**5,272.48**	**1,766.80**	**137,444.47**	**1,397,566.25**
Acquisitions during the year	-	2,162,142.60	19,335.60	-	2,018.94	1,236,510.97	3,420,008.11
Increases during the year	-	-	-	-	-	-	-
Decreases during the year	-	-	-	-	-	-1,194,353.24	-1,194,353.24
Depreciation for the year	-	-676,940.45	-10,023.55	-2,357.92	-817.25	-	-690,139.17
Balance as at 31/12/2024	**-**	**1,233,503.91**	**19,578.59**	**2,914.56**	**2,968.49**	**179,602.20**	**2,933,081.95**

The balance sheet items “Decreases during the year” is referred to the completion in 2024 of the supply of scientific instruments in progress at the end of 2023; its value is included in under the acquisition made during the year.

Intangible Assets

Balance as at 31/12/2023	Balance as at 31/12/2024	Difference
19,728.62	38,300.62	18,572.00

Historical costs at 31/12/2024 are as follows:

Description	Balance as at 31/12/2023	Operating increments	Operating decreases	Depreciation for the year	Value on 31/12/2024
Concessions, licenses, trademarks	19,728.62	36,481.56	-	-17,909.56	38,300.62
Intangible assets in progress	-	-	-	-	-
Total	**19,728.62**	**36,481.56**	**-**	**-17,909.56**	**38,300.62**

Current Assets

Short-term Credits

The balance is divided according to the deadlines of the credits:

Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
135,987.35	90,313.88	-45,673.47

The composition of the amount as at 31/12/2023 is as follows:

Description	Within 12 months	Over 12 months	Over 5 years	Total
Advances to Universities	24,000.00	-	-	24,000.00
Other receivables	11,205.66	-	-	11,205.66
Tax advances	37,690.51	-	-	37,690.51
Advances to suppliers	11,080.55	-	-	11,080.55
Receivables from customers	6,337.16	-	-	6,337.16
Total	**90,313.88**	**-**	**-**	**90,313.88**

- The balance sheet item "Advances to Universities"(€ 24,000.00) represents the part of the expenses paid to Universities for activities in relation to the PHD programmes running in the period 2023-2025.
- The balance sheet item “Other receivables” mainly refers to payments made in relation to the destination of the severance indemnity of an employee to supplementary pension funds (€ 5,607.02). The remaining part is referred to VAT credits (€ 5,436.20) related to purchases linked to the commercial activity of the Consortium, to and other credits of different nature (€ 162.44).
- The balance sheet item “Tax advances” mainly refers to advance payments made in June and November 2024. (€ 37,041.00). These advance payments have been calculated on the basis of the fiscal charge from the previous year. The remaining part (€ 649.51) refers to tax advances related to the severance indemnities calculated for 2024.
- The balance sheet item “Receivables from funding agencies” refers to a contribution of € 6,337.16 requested to the Central Europe Initiative in relation to the organisaion of a scientific event held in October 2024.

Inventories

No values are entered for this item.

Cash and Cash Equivalents

The balance item Cash and Cash Equivalents represents the following financial positions:

- Cash at the bank at the end of the financial year. It represents liquid assets and cash equivalents at the end of the year.
- Term deposit at the bank at the end of the financial year. It represents short term liquidity deposit at the end of the year.

Cash deposited and fixed term deposit at the bank Unicredit Banca Spa:

Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
6,875,385.68	5,805,703.30	-1,069,682.38

In this context, the Consortium is in a credit position towards the Institute Unicredit, Agency of Trieste, where it has opened a current account for financial management. In September 2024, a sum of € 3,005,000.00 was delivered to this account by the Ministry of Education, University and Scientific Research through AREA di Ricerca of Trieste, to support the Consortium’s activities for the year reviewed. This amount included the Italian membership fee for 376,188.00 euro. In February 2024, CERIC received from the EU an amount of € 177,028.20, as advance payment for the OPV Stability project funded by the EU. In April 2024, CERIC received from the EU an amount of € 90,042.62, as advance payment for the OSCARS project, in June 2024 an amount of 7,857.39 for the REMADE project, and an amount of 6,365.85 in October 2024 as advance payment for the project IMPRESS, all funded by the EU.

During the year 2024 CERIC received an amount of 89,057.91 as net bank interest for the time deposits hold in that period and other interests due from 2023.
An amount of 20,004 euro was credited to CERIC in relation to the commercial service concluded in 2023 and advance payments referred to the commercial contracts signed in 2024.
During the year 2024 CERIC received an amount of total 402,496.00 by the member states other than Italy in relation to the annual financial contributions agreed by the General Assembly for the same year.

Description	Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
Bank deposits	2,875,385.68	805,703.30	-2,069,682.38
Fixed term deposits	4,000,000.00	5,000,000.00	1,000,000.00
Total	**6,875,385.68**	**5,805,703.30**	**-1,069,682.38**

Prepayments and Accrued Income

Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
155,404.62	15,064.92	-140,339.70

This item measures income and expenses whose competence is delayed or advanced with respect to cash or documentary; they disregard the date of payment or collection of related income and expenses common to two or more years and distributable on time. The main part of this amount (€ 10.039.43) refers to prepaid expenses related to the general costs of the Consortium (€7,529.60) and to accrued incomes for 2024 related to the term deposit interests (€ 2,509.83)
The remaining part refers to multiannual scholarship commitments (€ 5,025.49).

Reserves

No values are entered for these items.

Accumulated Profits

No values are entered for these items.

Non-current Liabilities

Other Long-term Debts and Liabilities

Long-term advance Payments received for externally funded projects

Description	ReMade	IMPRESS	ERIC Forum 2	ERA SHUTTLE	OPV Stability	OSCARS	TOTAL
Balance as at 31/12/2022	-	39,321.41	83,573.86	171,398.16	-	-	294,293.43
Expenses rescheduling	-	-28,500.00	- 83,573.86	- 41,000.00	78,500.00	24,000.00	-50,573.86
Balance as at 31/12/2023	**0.00**	**10,821.41**	**0.00**	**130,398.16**	**78,500.00**	**24,000.00**	**243,719.57**

Pensions Fund and Other Benefits for Compensation Employment

Severance indemnities for employees.

Description	Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
Severance indemnities for employees	222,340.56	285,454.99	63,114.43

The item is made up as follows:

Description	Initial value 31/12/2023	Plan balance 2024	Severance indemnities transferred to complementary social security funds	Contribution to national funds for employees (FPLD)	Severances paid during the year	End value 31/12/2024
Severance indemnities for employees	218,326.64	70,265.88	-	- 5,061.74	- 4,366.73	279,164.05
Severance indemnities transferred to complementary social security funds	4,013.92	2,277.02	-	-	-	6,290.94
Total	**214,663.04**	**53,029.74**	**590.13**	**3,775.49**	**41,006.60**	**222,340.56**

The severance set aside figure represents the actual debt of the Consortium at 31/12/2024, to its employees in force at that date.

The contribution to FPLD refers to the sum withheld from the severance indemnities of employees in favour of national social security institutions as a contribution to general social security purposes.

The amount of the severance indemnities paid refers for to the conclusion of a permanent employment contracts during 2024 for € 4,366.73..

Current Liabilities

Other Short-term Debts and Liabilities

Debts

Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
295,478.72	344,959.58	49,480.86

Debts are valued at their nominal value.

The composition of the aforementioned amounts is as follows:

Description	31/12/2023	31/12/2024	Variation
Debts to providers	150,408.16	148,148.03	-2,260.13
Tax liabilities	98,955.23	125,763.17	26,807.94
Payables to social security institutions	46,115.33	71,048.38	24,933.05
Total	**295,478.72**	**344,959.58**	**49,480.86**

- “Debts to providers” are stated net of possible trade discounts.
- The item “Debts to providers” (€ 148,148.03) includes debts to third parties, mainly relating to services purchased on credit. This item appears on the entity's balance sheet as a current liability, since the expectation is that the liability will be met in less than a year.
- The item "Tax payables" includes liabilities for specific taxes, and is composed of withheld taxes for employees, associates and collaborators amounting to € 54,868.54, together with € 26,290.63 of VAT to be paid in 2025, and taxes due by the Consortium (€ 44,604.00). With reference to this last item, two advance payments were made in 2024 for a total amount of € 37,041.00 included in the short-term credits
- “Payables due to social security institutions" includes the amount of social security contributions relating to employees, accrued but not paid as at 31 December 2024, amounting to € 71,048.38.
- "Other payables", see table below, includes remaining debts, which by nature cannot be described above, including amounts due by CERIC to staff for all liabilities accrued to them, in accordance with current legislation and Personnel Regulations, including the value of accrued vacation paid at the time of reporting. This account at 31/12/2024 was as follows:

Description	31/12/2023	31/12/2024	Variation
Other payables	274,684.21	279,575.98	4,891.77

Description	31/12/2024
Payables to employees (holidays and leave not taken)	155,972.57
Payables to bodies	10,875.00
Other debts of a different nature	112,728.41
Total	**279,575.98**

The item “Payables to bodies” relates to the fee due by the Consortium to a member of the IAEC.

Debts are evaluated at their nominal value.

The final value as at at 31.12.2024 refers mainly to the following expenses:

- Costs for the spaces charged by Elettra for hosting the statutory seat in 2024 (€ 39,323.29)
- Access costs for 2024 related to beamline LISA located at ESRF and managed by CNR. (€ 60,000.00)
- Users travel costs to be reimbursed in 2024 (€ 2,394.99)
- Travel costs if the employees and collaborators to be paid in 2025 (€ 2,674.57).

Short-term advance Payments received for externally funded projects

The item "Advance payments for externally funded projects" includes the amounts listed in the table referring to the following running projects:

Description	ReMade	IMPRESS	ERIC Forum 2	ERA SHUTTLE	OPV Stability	OSCARS	TOTAL
Balance as at 31/12/2023	69,015.90	39,321.41	83,573.86	171,398.16	-	-	254,789.52
Advance payment received from the EC during 2024	7,857.39	-28,500.00	- 83,573.86	- 41,000.00	78,500.00	24,000.00	281,294.06
Accrual progress report for 2024	-13,238.68	39,321.41	83,573.86	171,398.16	-	-	-239,005.94
Expenses rescheduling	-	-28,500.00	- 83,573.86	- 41,000.00	78,500.00	24,000.00	50,573.86
Balance as at 31/12/2024	**63,634.61**	**45,074.40**	**38,212.18**	**90,015.51**	**77,860.89**	**32,853.91**	**347,651.50**

Contingent liabilities

Description	Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
Contingent liabilities	40,783.62	40,783.62	-

The final value as at 31.12.2024 refers to the potential credit claimed by a fiscal consultancy firm. At the end of the financial year, the definition of the actual debt is not yet completed.

Deferred Income and Accrued Expenses

For accounting the contribution provided by Italy, the indirect method has been chosen and the stated amount is representative of the portion attributable to future financial years.

Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
7,201,702.46	7,340,319.43	138,616.97

The item breaks down as follows:

Description	31/12/2024
Deferred income	7,340,039.43
Accrued expenses	280.00

The balance sheet item "Deferred income" measures the portion of the contribution funded by the Italian MIUR for the activities of the CERIC statutory seat, deferred to the following years for the amount of € 6,639,223.83;.
The annual contribution of the Member states for 2024 committed to specific investment activities deferred to 2025.

The amount of € 7,340,039.43 is derived as follows:

Category	Deferred incomes as at 31.12.2023	Italian Hosting premiun contribution for 2024 to CERIC	Membership fees for 2024	Consortium general expenses for 2024 covered by covered by the Member states contributions and the Italian Hosting premium	Consortium investments made in 2024 covered by FOE ante 2024	Membership fees to be spent starting from 2025	Deferred incomes as at 31.12.2024
Deferred income	7,166,922.46	2,589,488.71	77,868.40	-2,292,789.29	-902,266.45	700,815.60	7,340,039.43

The amount of the deferred incomes is composed as follows:

Description	Amount
Resources committed to cover the depreciation quotes for the period 2025 -2031 by using the FOE contributions of the past years	78,728.90
Resources committed to cover the investment within the project INTEGRA	1,067,371.89
Resources committed to cover the investment within the research project MAG-ALCHEMI	66,885.04
Resources committed to cover the HR and technical investment within the Expression of Interest (EOI) call	4,441,853.53
Resources committed to cover the investments made within the Battery Plan Programme	625,871.82
Carry over from 2024	358,512.65
Resources committed to cover the expenditure related to the use of the membership fees	700,815.60
Total deferred income as at 31.12.2024	**7,340,039.43**

The balance sheet item "Accrued expenses" (€ 280.00), measures the expenses that are recognised on the books before they have been paid. These expenses are recorded in the accounting period in which they are incurred. In particular they referred to the costs arising from the activities foreseen within the PHDs programs agreed with the Universities.

Income Statement

Financial Revenues

Revenue items primarily identify the portion of the contribution for the financial year allocated by Italy for the Consortium's activities through the public company Area di Ricerca, to cover the expenses of management, as well as the revenues related to projects externally funded.
The Italian contribution for 2024 (€ 2,628,812.00), recalculated considering the additional activities performed by Elettra-Sincrotrone Trieste S.c.p.A. (€39,323.29) for the spaces used by CERIC for its statutory seat, corresponds to € 2,589,488.71. The portion of the FOE 2024 spent in the current financial year corresponds to € 2,214,920.89. This amount mainly covers the operational costs of the Consortium (staff costs, general services, consumables for the seat). Part of the general costs in 2024 were covered by the accumulated revenues related to the projects funded by the EU (€ 25,340.07). The mayor part of the depreciation costs are related to CERIC investment plans (Battery plan, INTEGRA project, EOI projects). These costs were covered mainly by FOE funds of the previous years.

Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
2,927,480.77	3,386,521.05	459,040.28

The composition of the amount at 31.12.2024 is as shown in the following tables:

Category	31/12/2023	31/12/2024	Variation
MIUR ordinary contribution	3,005,000.00	3,005,000.00	-376,188.00
Cost charged by the Italia RE for the spaces used by CERIC for the statutory seat	-39,302.33	-39,323.29	-20.96
FOE funds of the previous years used to cover Battery plan investments to be completed	-134,074.46	0.00	134,074.46
FOE funds 2023 used to cover the depreciation costs related to investments made up to 31.12.2023	-6,455.87	0.00	6,455.87
FOE funds 2024 used to cover the depreciation costs related to investments made up to 31.12.2024	-	-16,055.17	-16,055.17
FOE funds of the current financial year to be spent in the following years	-539,481.24	-358,512.65	180,968.59
Subtotal	**2,285,686.10**	**2,214,920.89**	**-70,765.21**
Use of the carry over from previous years	574,687.77	902,266.45	327,578.68
Subtotal	**2,860,373.87**	**3,117,187.34**	**256,813.47**

Another relevant part of the revenue items is represented by the contributions of the Member to the operating costs for 2024.

The total amount of € 77,868.40 is 10% of the total contributions from the member states for 2024.

According to the resolution 8th May 2023, the General Assembly (GA) agreed that as long as the contribution by the Host Member State of CERIC-ERIC allows covering the statutory operations fully, 90% of the Member's annual contributions are dedicated to supporting actions integrating the capabilities of the Member's Partner Facilities, such as PhDs, post-docs, joint research projects, infrastructure investments and promotion of CERIC- ERIC Partner Facilities research offer. These will be agreed upon by the GA, assuring that, over a 5-year average, this support to each Partner Facility will equal at least 90% of the cash contribution provided by the relevant Member during this period.

Category	31/12/2023	31/12/2024	Variation
Austrian contribution for 2024	0.00	10,867.60	10,867.60
Czech contribution 2024	0.00	7,610.40	7,610.40
Croatian contribution 2024	0.00	4,128.80	4,128.80
Hungarian contribution 2024	0.00	5,978.40	5,978.40
Romanian contribution 2024	0.00	7,651.20	7,651.20
Slovenian contribution 2024	0.00	4,013.20	4,013.20
Italian contribution 2024	0.00	37,618.80	37,618.80
Total other incomes	**0.00**	**77,868.40**	**77,868.40**

Category	31/12/2023	31/12/2024	Variation
Commercial services	22,559.00	17,207.00	-5,352.00
CEI Project Contact3	0.00	6,337.16	6,337.16
H2020 RE-Made Project	28,796.90	13,238.68	-15,558.22
H2020 ERA SHUTTLE Project	5,355.96	50,647.56	45,291.60
H2020 IMPRESS Project	5,277.56	8,958.12	3,680.56
H2020 OPV Stability Project	0.00	20,667.31	20,667.31
H2020 OSCARS Project	0.00	33,188.71	33,188.71
H2020 ERIC FORUM 2	0.00	112,305.56	112,305.56
Other incomes	5,117.48	6,781.61	1,664.13
Total other incomes	**67,106.90**	**269,331.71**	**202,224.81**

Contributions for Operating Expenses

The amount of the Italian contribution 2024 for the activities of the statutory seat of the Consortium is € 2,214,920.89. This amount will be reported to the Italian Ministry according to the FOE reporting rules. This amount covered part of the costs for personnel, bodies, consultancies, and other costs of the seat, not covered by specific externally funded projects.

Contributions In-Kind

No values are entered for these items.

Costs

Operating Costs

Costs for Raw materials, Supplies, Consumables and Goods

This category includes costs incurred for the supply of consumables.

Category	Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
Costs for raw materials, supplies, consumables and goods	3,437.71	17,417.03	13,979.32

Most of the total value for 2023 refers to costs incurred to support the internal research project INTEGRA.

Services Costs

It has been decided to divide the item service costs, to facilitate the clarity of the budget, into the following categories of expenses:

Category	31/12/2023	31/12/2024	Variation
Commercial services	19,110.00	**15,400.00**	-3,710.00
Legal, fiscal and administrative consultancy	20,839.84	**8,495.44**	-12,344.40
Technical consultancies	6,564.78	**6,014.78**	-550.00
Administrative collaborators	5,580.62	**10,320.00**	4,739.38
Scientific and technical collaborators	104,057.15	**110,523.58**	6,466.43
Social security contributions of collaborators	41,879.02V	**43,500.20**	1,621.18
Health contribution for collaborators	468.05	**502.26**	34.21
ISTAC remunerations	16,428.58	**17,053.62**	625.04
Travel costs for employees, collaborators, and bodies	89,516.54	**150,772.21**	61,255.67
Travel costs for users	107,144.99	**106,046.89**	-1,098.10
Insurances	11,168.18	**11,225.10**	56.92
Representation costs	3,731.91	**5,296.91**	1,565.00
Consulting and salaries processing	29,763.02	**33,416.83**	3,653.81
Mobile phones	8,947.52	**7,298.71**	-1,648.81
Annual software licenses	341.36	**4,985.83**	4,644.47
Workshops, seminars and publications	10,072.33	**31,320.51**	21,248.18
Canteen expenses	17,107.65	**22,205.82**	5,098.17
Bank charges	1,559.66	**1,383.17**	-176.49
Postal charges	876.82	**1,543.45**	666.63
Agreement with Universities to support PHDs	355,696.80	**189,125.19**	-166,571.61
Maintenances	2,367.57	**7,075.38**	4,707.81
Training costs	17,598.79	**11,334.47**	-6,264.32
Transportation services	1,564.30	**4,950.00**	3,385.70
Other costs	83,421.23	**107,325.70**	23,904.47
Technical services	352.12	**1,144.85**	792.73
Total	**908,260.90**	**908,260.90**	**-47,897.93**

The item “Other costs” includes mainly costs related to the access costs to external research infrastructures (€ 60,000.00), and other minor costs.

Personnel Costs

Personnel expenses: breakdown

Category	31/12/2023	31/12/2024	Variation
Wages and salaries	690,897.58	930,010.13	239,112.55
Social security charges	203,665.58	276,587.43	72,921.85
Seconded personnel (IKCs against payment)	0.00	0.00	0.00
Severance indemnities	51,122.80	73,402.94	22,280.14
Allowances to be paid	107,000.16	155,972.57	48,972.41
Director	184,087.04	204,064.08	19,977.04
Social security charges of bodies	26,510.63	31,249.62	4,738.99
Auditors and IAEC	175,000.00	175,000.00	0.00
Fellowships	8,121.48	15,129.70	7,008.22
Total	**1,446,405.27**	**1,861,416.47**	**415,011.20**

Use of Third-Party Materials or Property

Category	Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
Rentals	0.00	610.00	610.00

Other Operating costs

Other operating costs: breakdown

Category	31/12/2023	31/12/2024	Variation
Membership fees	12,917.00	5,500.00	-7,417.00
Rounding	134.95	159.89	24.94
Other taxes	2,139.66	31,086.03	28,946.37
Other expenditures	1,908.72	4,221.31	2,312.59
Total	**17,100.33**	**40,967.23**	**23,866.90**

Depreciation of Tangible and Intangible Assets

Depreciation is calculated on the basis of the useful life of the asset and its use in production. For the first year of use, the percentages applied have been reduced by half.

Intangible Assets

Description	Depreciation Rate	Amount
Concessions and licenses	20%	17,909.56
Total amortisation of intangible assets		**17,909.56**

Tangible Assets

Description	Depreciation Rate	Amount
Office machinery	20%	10,023.55
Equipment	20%	676,940.45
Telephony and mobile telephony	20%	817.25
Office furniture	15%	2,357.92
Total amortisation of fixed assets		**690,139.17**

Taxation

Current tax	Balance as at 31/12/2023	Balance as at 31/12/2024	Variation
IRAP	37,178.00	44,596.00	7,418.00
IRES	0.00	8.00	8.00
Total	**37,178.00**	**44,604.00**	**7,426.00**

The annual tax related to institutional activity (IRAP) is calculated on the amount of salaries paid to employees, the amount of fees paid to collaborators and the costs of contracts for temporary employment, with the exception of remunerations paid for researchers. The fiscal charge related to the commercial activity is equal to 55,00 Euro..
The Consortium, in the context of purchases realized, and within the limits following from the Statute, may use VAT exemptions granted on the basis of Article 143(1)(g) and Article 151(1)(b) of Council Directive 2006/112/EC, and in accordance with Articles 50 and 51 of Implementing Regulation (EU) No. 282/2011 of the Council, and on the basis of Article 12 of Directive 2008/118 /EC.

Financial Costs and Revenues

Under “Financial management”, accrued interest income on the bank account of the Consortium is stated as of 31.12.2024.

Interest on Current Account, Rounding and Exchange Rate Costs

The item represents remuneration on deposits of the Consortium on current account N. 000103334723 opened at Unicredit Banca.

Category	31/12/2023	31/12/2024	Variation
Interest on current account	7,485.10	117,046.58	109,561.48
Exchange rate costs	-272.22	-109.67	162.55
Total	**7,212.88**	**116,936.91**	**109,724.03**

Report of the commercial activities

The limited commercial activities of the Consortium have been managed through a separate account. In 2023, one commercial contract was concluded for the value of € 17,207.00.

Revenues	
Commercial services	17,207.00
Costs	
Collaboration contracts related to the commercial activity	15,400.00
General costs*	1,637.34
Final balance	169.66

*General costs have been calculated according to the Italian fiscal rules for commercial activities performed by non-commercial entities.
In particular, the calculation refers to the incidence of the commercial activities (€17.207,00) compared to the total amount of the revenues accounted for 2024 (€ 3.581.504,81). The ratio corresponds to 0.48 % approximately.
The resulting percentage has been applied to the amount of € 364.447.21, corresponding to the following general cost categories, common to both institutional and commercial activities and not reported within project externally funded.

Category	31/12/2024	%
Legal, fiscal and administrative consultancy	20,942.49	161.26
Insurances	11,225.10	86.43
Consulting and salaries processing	33,416.83	257.31
Mobile phones	7,298.71	56.20
Personnel	204,064.08	1,571.29
Bodies	87,500.00	673.75
Total	**364,447.21**	**2,806.24**

Following IPSAS 14, this paragraph reports about events that occurred between the reporting date (31.12.2023) and the date when these Financial Statements were approved by the General Assembly.
In this context, it is noted that no relevant event occurred.

Management Report

Comparison between Final Budget and Annual Accounts

Starting from the budget for 2024 approved by the GA in November 2023, during the financial year 2024 some budget adjustments were necessary as the result of the following:

REVENUES

1. The calculation of the actual carry-over for 2023. The 2024 budget was approved in November 2023 by the GA. taking in to account an estimate of the carry-over for the year at closing. (+39,481.24 Euro).
2. The acquisition of a new commercial contract. (+ 17,207.00 Euro).
3. The bank interests related to the time deposits finalized in 2024 (+ 117,046.58 Euro).
4. The signature of a collaboration research contract with the Central Europe Initiative (+ 6,337.41 Euro).
5. Other minor incomes (+ 6,850.39 Euro)
6. The redistribution of the carry over 2022 and 2023 to the running investment plans.
7. The postponement of the polish member contribution for 2024 (-141,316.00 Euro)

Description	Initial budget	Changes	Final budget	Total expenses	% expenditure
Commercial services	-	17,207.00	17,207.00	17,207.00	100.00
Italian hosting contribution	5,153,812.00	-	5,153,812.00	5,098,433.54	98.93
Member contributions CZ	76,104.00	-	76,104.00	76,104.00	100.00
Member contributions HR	41,288.00	-	41,288.00	41,288.00	100.00
Member contributions HU	59,784.00	-	59,784.00	59,784.00	100.00
Member contributions PL	141,316.00	141,316.00	-	-	-
Member contributions AT	108,676.00	-	108,676.00	108,676.00	100.00
Member contributions RO	76,512.00	-	76,512.00	76,512.00	100.00
Member contributions SLO	40,132.00	-	40,132.00	40,132.00	100.00
Member contributions IT	376,188.00	-	376,188.00	376,188.00	100.00
Carry over from 2023	510,000.00	510,000.00	-	-	-
Carry over committed to EoI investments	3,707,000.00	851,796.36	4,558,796.36	331,429.75	7.27
Carry over committed to batteries	-	414,700.00	414,700.00	71,730.36	17.30
Carry over from 2022	827,000.00	827,000.00	-	-	-
CEI CONTACT 3 - Science at CERIC	-	6,337.16	6,337.16	6,337.16	100.00
Bank interests	-	117,046.58	117,046.58	117,046.58	100.00
Carry over committed to INTEGRA	590,700.00	-	590,700.00	400,123.46	67.74
Carry over committed to other investment	-	98,984.88	98,984.88	98,984.88	100.00
EU/Regional projects	394,000.00	-	394,000.00	239,005.94	60.66
Other minor incomes	-	7,083.96	7,083.96	6,850.39	96.70
TOTAL	**12,102,512.00**	**34,839.94**	**12,137,351.94**	**7,165,831.06**	**59.04**

COSTS and INVESTMENTS

1. The recalculation of the resources available for the membership fees implementation for 2024, following the postponement of the polish annual contribution. (-127,184.00 Euro).
2. The additional resources necessary to cover the remuneration of the employees not covered by project funded by other entities. (61,800.00 Euro).
3. The additional resources necessary to cover the annual taxation of the Consortium (+6,000.00).
4. The additional resources necessary to cover the fixed assets for the statutory seat of the Consortium (+5.000,00 Euro).
5. The additional resources necessary to cover the access costs for 2024 (25.000,00 Euro).
6. The additional resources necessary to cover the costs for the PHD programme 2020-2024 (+58.000,00 Euro).
7. The additional resources necessary to cover the cost of the project funded by the Central Europe Initiative in 2024 (+37,105.00 Euro).
8. The additional resources linked to the acquisition of a new commercial contract. (+16.300,00 Euro).

All the above-mentioned changes represent cost neutral solutions, being funded by the additional resources acquired during the year by the Consortium, or being the result of a redistribution of the financial resources among different budget lines.

Incurred and planned costs and investments

Description	Initial budget	Changes	Final budget	Total expenses	% expenditure
Membership fees implementation plan	828,000.00	-127,184.40	700,815.60	-	-
Impact assessment study	80,000.00	-35,000.00	45,000.00	4,636.00	10.30
Financial coverage new activities 2024	167,620.00	-25,000.00	142,620.00	-	-
Coll. Agg. IT PF and CERIC	2,525,000.00	-	2,525,000.00	2,525,000.00	100.00
INTEGRA (VAT included)	414,700.00	-68,000.00	346,700.00	339,192.80	97.83
Bodies - Remuneration	232,900.00	-	232,900.00	208,553.62	89.55
Remuneration for employees	1,396,364.00	61,800.00	1,458,164.00	1,425,398.62	97.75
Commnication	33,416.00	-	33,416.00	26,538.94	79.42
Travel expenses	155,000.00	-	155,000.00	86,376.27	55.73
External services, consultants, consumables	286,500.00	-	286,500.00	235,023.98	82.03
Fixed assets	15,000.00	5,000.00	20,000.00	18,006.27	90.03
Taxes	40,000.00	6,000.00	46,000.00	44,743.21	97.27
Support of Italian RE to S.S.	60,000.00	-	60,000.00	-	-
IT expenses	30,000.00	-	30,000.00	6,639.17	22.13
External users	90,000.00	25,000.00	115,000.00	106,854.93	92.92
Batteries	604,810.00	-	604,810.00	168,576.83	27.87
PhD programme 2020-2024	140,000.00	58,000.00	198,000.00	197,733.56	99.87
Commercial activity	-	16,300.00	16,300.00	15,514.97	95.18
EoI investments plan (VAT included)	4,549,210.67	80,819.34	4,630,021.01	1,598,408.52	34.52
Access costs	60,000.00	-	60,000.00	60,000.00	100.00
CEI 2024	-	37,105.00	37,105.00	34,388.94	92.68
EU / Regional projects	394,000.33	-	394,000.33	225,114.64	57.14
TOTAL BUDGET	**12,102,512.00**	**34,839.94**	**12,137,351.94**	**7,326,701.27**	**60.36**

The following tables are aimed to represent that, despite the difference between the total expenses indicated in the final budget for 2024 (7,236.701.27) and the total revenues indicated in the final budget for the same year (7,165,831,06), all the initiatives planned in 2024 are covered by the accrued incomes indicated in the financial statements for 2024.

RECONCILIATION between BUDGET and FINANCIAL STATEMENTS – EXPENSES	
Description	**Amount**
TOTAL Expenses (Contracts signed, incurred costs and investments)	7,326,701.27
(-) FOE FUNDS TRANSFERRED TO THE ITALIAN PF	-2,525,000.00
(-) INVESTMENTS	-2,399,580.90
(-) Contracts signed but not completed as at 31.12.2024	-457,800.27
(+) DEPRECIATION	708,048.73
Contracts signed in 2023 and completed within Dec 2024	929,133.98
Total costs (as indicated in the profit and loss account for 2024)	**2,934,965.87**

RECONCILIATION between BUDGET and FINANCIAL STATEMENTS – REVENUES	
Description	**Amount**
Total Revenues	7,165,831.06
(-) FOE FUNDS TRANSFERRED TO THE ITALIAN PF	-2,525,000.00
(-) 90% of the membership fees	-700,815.60
(-) CARRY OVER from 2024	-358,512.65
Total revenues (as indicated in the profit and loss account for 2024)	**3,581,502.81**

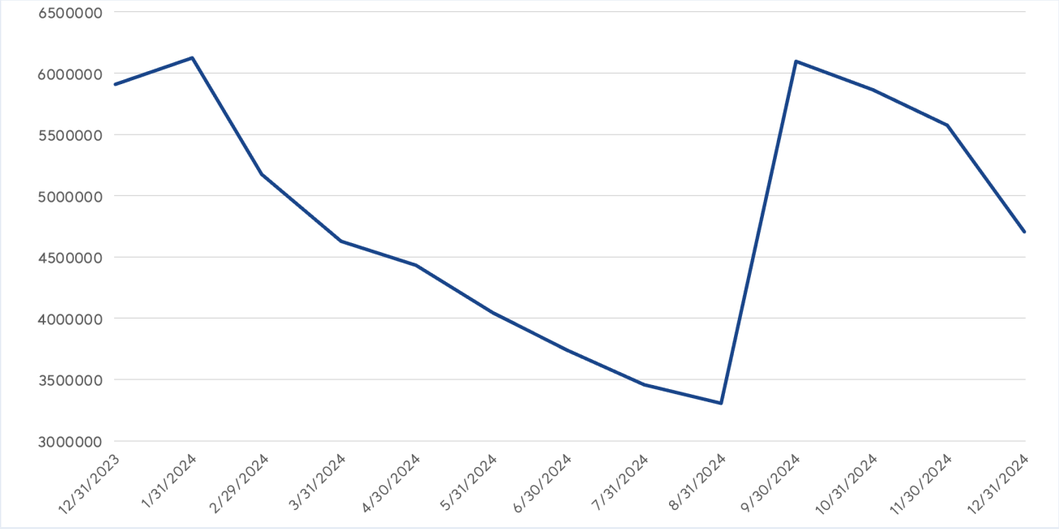
Statement of Cash Flow

The cash flow statement identifies the sources of cash inflows, the items on which cash was expended during the year and the cash balance as at the end of the year.
Inflows and outflows are classified on the basis of their (operating or investment) nature.
In the following table is included information about the historical changes in cash (and cash equivalent) referring to operating, investing and financing activities..

Statement of cash flows for the years	2024	2023
Cash flows from operating activities		
Receipts		
Externally funded projects	281,294.06	557,783.87
Commercial activities	20,004.00	38,002.00
Hosting premium contribution	2,628,812.00	3,005,000.00
Contribution from Member states	778,684.00	-
Interest received	89,057.91	441.19
Other receipts	4,911.54	854.83
Payments		
Payments to Staff	-947,389.95	-878,826.29
Other operating payments	-1,660,912.77	-1,505,128.77
Payments to project partners	-	-
Net Cash from Operating Activities	**1,194,460.79**	**1,218,126.83**
Cash flows from investment activities		
Purchase of plant and equipment	-2,264,143.17	-432,801.97
Sale of plant and equipment	-	-432,801.97
Other	-	-
Net Cash Flow from Investment Activities	**-2,264,143.17**	**-432,801.97**
Cash flows from financing activities		
Proceeds from borrowings	-	-
Repayment of borrowings	-	-
Other	-	-
Net Cash Flow from Financing Activities	-	-
NET INCREASE/(DECREASE) IN CASH	**-1,069,682.38**	**785,324.86**
CASH, BEGINNING OF THE YEAR	**6,875,385.68**	**6,090,060.82**
CASH, END OF THE YEAR	**5,805,703.30**	**6,875,385.68**

Net Financial Position - Trend for the period Jan-Dec 2024

The Net Financial Position represents the net debt position of the Consortium during the year, through comparison of the following balance items: + cash and cash equivalent | + short-term monetary credits | - short-term monetary debts



Additional disclosures on in-kind resources (with reference to Directive 2013/34/EU)

In relation to in-kind contributions, which statutorily constitute a particularly significant element in terms of the resources and organization that can be used by the Consortium, it should be noted that it was not possible to acquire all the accounting values for 2024 according to the principles of consistency and auditability on the basis of the revised "Methodology for Defining the Values Involved in the CERIC-ERIC Activities, and to Detail In-kind Contributions" approved by the General Assembly in June 2018.

However, it needs to be highlighted that, even before the set-up of the Consortium, some of the concerned PFs manifested themselves through this particular mode of contribution, which then allowed the immediate and consistent start of activities.

These values were quantified, albeit with the limitations set forth above, by the various PFs and are shown in the tables below in order to provide supplementary information, which enables a better understanding of the relevance of the total resources used by CERIC in the whole financial year 2024.

Value of the PFs and in-kind contribution. Consolidated data (2024)

Total costs of the ordinary scientific/technical activities of the Partner Facilities in 2024 - COMMITTED IN-KIND							
	Recurrent costs						
PF	**Personnel costs**	**Consumables**	**Services / travels / utilities**	**Overheads**	**Technical devaluation & maintenance, lease/rent costs of equipment & spaces**	**Cost of access committed to CERIC**	**Total**
AT	-	-	-	-	-		
HR	-	-	-	-	-	63,210.68	**63,210.68**
CZ	-	-	-	-	-	9,660.36	**9,660.36**
HU	1.069,624.00	-	412,348.00	370,493.00	12,400.73	-	**1,864,865.73**
IT	182.978.84	-	-	45,744.71	-	3,686,425.48	**3,915,149.03**
PL	-	-	-	-	-	532,100.01	**532,100.01**
RO	51,474.00	3,108.50	5,967.10	15,137.40	-	76,281.49	**151,968.49**
SI	-	-	-	-	-	233,677.97	**233,677.97**
Tot.	**1,304,076.84**	**3,108.50**	**418,315.10**	**431,375.11**	**12,400.73**	**4,601,355.99**	**6,770,632.27**

Annex 2

Scientific Publications by CERIC Users

One-hundred and twenty-nine (129) articles were published in 2024, with a cumulative impact factor of 1107 (versus 902 in 2023) and an average impact factor of 7,79 (versus 8,43 in 2023):

(1) *Growth of bilayer stanene on a magnetic topological insulator aided by a buffer layer,* Barman S., Bhakuni P., Sarkar S., Bhattacharya J., Balal M., Manna M., Giri S., Pariari A.K., Skala T., Hücker M., Batabyal R., Chakrabarti A., Barman S.R., Physical Review B, 2024

(2) *Bimetallic Pd–Rh Nanoparticles Supported on Co3O4(111): Atomic Ordering and Stability,* Simanenko A., Škvára J., Samal P.K., Fusek L., Kastenmeier M., Ronovský M., Skála T., Tsud N., Mehl S., Johánek V., Mysliveček J., Brummel O., Lykhach Y., Libuda J., Journal of Physical Chemistry C, 2024

(3) *Structuring lipid nanoparticles, DNA, and protein corona into stealth bionanoarchitectures for in vivo gene delivery,* Renzi S., Digiacomo L., Pozzi D., Quagliarini E., Vulpis E., Giuli M.V., Mancusi A., Natiello B., Pignataro M.G., Canettieri G., Di Magno L., Pesce L., De Lorenzi V., Ghignoli S., Loconte L., Montone C.M., Capriotti A.L., Laganà A., Nicoletti C., Amenitsch H., Rossi M., Mura F., Parisi G., Cardarelli F., Zingoni A., Checquolo S., Caracciolo G., Nature Communications, 2024

(4) *Bioassay-Guided Isolation and Identification of Antibacterial Compounds from Invasive Tree of Heaven Stem and Trunk Bark,* Cselőtey A., Baglyas M., Király N., Ott P.G., Glavnik V., Vovk I., MÓRicz Á. M., Molecules, 2024

(5) *Anticancer potential of copper(I) complexes based on isopropyl ester derivatives of bis(pyrazol-1-yl)acetate ligands,* Pellei M., Santini C., Caviglia M., Del Gobbo J., Battocchio C., Meneghini C., Amatori S., Donati C., Zampieri E., Gandin V., Marzan C., RSC Medical Chemistry, 2024

(6) *Evidence of Gd substitution for Y in YBCO films with Gd excess,* Reale P., Pinto V., Cayado P., Celentano G., Armenio A.A., Rufoloni A., Santoni A., D'Acapito F., Journal of Alloys and Compounds, 2024

(7) *Limited dissolution of transition metals in the nanocrystalline cerium (IV) oxide,* Ducka A., Błaszczak P., Zając M., Mizera A., d'Acapito F., Bochentyn B., Ceramics International, 2024

(8) *Extending the Pre-ordered Precursor Reduction strategy to L10 ternary alloys: the case of MnFePt,* Capobianchi A., Imperatori P., Cannas C., Rusta N., Locardi F., Slimani S., Ferretti M., Peddis D., D'Acapito F., Tauanov Z., Laureti S., Varvaro G., Journal of Alloys and Compounds, 2024

(9) *Robust Molecular Anodes for Electrocatalytic Water Oxidation Based on Electropolymerized Molecular Cu Complexes,* Amthor S., Ranu K., Bellido C.G., Salomón F.F., Piccioni A., Mazzaro R., Boscherini F., Pasquini L., Gil-Sepulcre M., Llobet A., Advanced Materials, 2024

(10) *Strain-Engineered Ir Shell Enhances Activity and Stability of Ir-Ru Catalysts for Water Electrolysis: An Operando Wide-Angle X-Ray Scattering Study,* Hrbek T., Kus P., Drnec J., Mirolo M., Nedumkulam H., Martens I., Novakova J., Skala T., Matolinova I., Advanced Energy Materials, 2024

(11) *Mechanistic Study of Ethanol Decomposition on Co3O4(111) and Pd/Co3O4(111) Model Catalysts,* Reindl S., Skvara J., Hauner J., Simanenko A., Kastenmeier M., Ronovsky M., Skala T., Tsud N., Kettner M., Mehl S.L., Vorochta M., Smid B., Retzer T., Myslivecek J., Brummel O., Johanek V., Lykhach Y., Libuda J., ChemCatChem, 2024

(12) *Synchrotron Micro-X-ray Diffraction in Transmission Geometry: A New Approach to Study Polychrome Stratigraphies in Cultural Heritage,* Morabito G., Marinoni N., Bais G., Cantaluppi M., Botteon A., Colombo C., Gatta G.D., Polentarutti M., Realini M., Possenti E., Minerals, 2024

(13) *Evidence for efficient anchoring in nitroxyl radical thin films: an experimental XPS/NEXAFS and theoretical DFT/TD-DFT study,* R. Totani, I. Ljubić, S.L. Mehl, V. Kalinovych, M. Jugovac, G. Bonano, A. Ciavardini, C. Grazioli, F. Galdenzi, S. D'Addato, M. de Simone, P.M. Sheverdyaeva, P. Moras, N. Tsud, M. Coreno

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(22) *Effect of pure (ligand-free) nanoparticles of magnetite in sodium chloride matrix on hematological indicators, blood gases, electrolytes and serum iron,* Lytvyn S.Y., Vazhnichaya E.M., Manno D.E., Kurapov Y.A., Calcagnile L., Rinaldi R., Carbone G.G., Semaka O.V., Nedostup Y.V., Micro and Nano Systems Letters, 2024

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Abbreviations

BoD	Board of Directors
CERIC	Central European Research Infrastructure Consortium
ED	Executive Director
EGERIC	Commission expert group to assess the implementation of the ERIC Regulation
ERA	European Research Area
EOSC	European Open Science Cloud
ERIC	European Research Infrastructure Consortium, a legal framework created by the European Commission to allow the operation of Research Infrastructures of pan-European interest.
FOE	Fondo Ordinario per il finanziamento degli Enti e istituzioni di ricerca (Ordinary Fund for the Financing of Research Entities and Institutions)
GA	General Assembly
IF	Impact Factor
IL&TT	Industrial Liaison and Technology Transfer
IR	Internal Regulations
ISTAC	International Scientific and Technical Evaluation Committee
MIUR	Italian Ministry of Education, University and Research
OA	Open Access
PaN	Photon and Neutron
PI	Principal Investigator
PF	Partner Facility
RE	Representing Entity
RI	Research Infrastructure
R&D	Research & Development
S&T	Science & Technology
TBAB	Technical Bettery Advisory Board

Austrian PF: X-ray and Light scattering at the Graz University of Technology (TUG) and Elettra
Graz and Trieste
www.tugraz.at

Croatian PF: Ion beams at the Ruđer Bošković Institute
Zagreb
www.irb.hr

Czech PF: Surface science at the Charles University
Prague and Trieste
http://spl-msb.mff.cuni.cz/

Hungarian PF: Neutrons at the Budapest Neutron Centre of the Centre for Energy Research (EK)
Budapest
www.bnc.hu

Italian PF: Synchrotron and laser light at Elettra Sincrotrone Trieste
Trieste
www.elettra.eu

Polish PF: Synchrotron light and Cryo electron microscopy at Solaris
Krakow
www.synchrotron.uj.edu.pl

Romanian PF: Electron microscopy and EPR at the National Institute of Materials Physics
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http://lab50.infim.ro

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