CERIC

Central European
Research Infrastructure
Consortium

Report 2020

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

Open for
Science

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Providing Open Access to Excellent Researchers

CERIC-ERIC is an integrated multidisciplinary research infrastructure for basic and applied research in all fields of materials, biomaterials and nanotechnology. Located in 8 countries in Europe (Austria, Croatia, Czech Republic, Hungary, Italy, Poland, Romania and Slovenia), it is open to researchers from all over the world. It offers a single access point to state-of-the-art facilities and techniques based on the use of electrons, ions, neutrons and photons. Each Member Country contributes to CERIC a high-quality Partner Facility (PF), which is available to researchers on the basis of a positive review from the International Scientific and Technical Advisory Committee (ISTAC) of CERIC.

Jana Kolar
CERIC Executive Director

Dear Reader,

This Annual Report presents our activities for the most challenging year so far, marked by the global pandemic, which severely interfered with the activities of analytical research infrastructures such as CERIC. With research centres, universities and research infrastructures limiting access to laboratories, or even closing down in spring, several activities moved online. Our main objective is to enable the excellent science of our users. To achieve it under the changed conditions, we have focused on supporting the enhanced use of remote access, which made it possible to implement more than two-thirds of the planned programme, of which a third was done through remote access. This could only be achieved by increased efforts of the instrument scientists at CERIC's facilities since remote access requires their more substantial support. We expect that the extent of remote usage will decrease once the pandemic is over; however, the remote access put in place will remain as an additional service to our users, often with a lower carbon footprint.

We have also set up a dedicated COVID-19 fast-track access to our instruments. The experiments were scheduled within one month from submitting the proposal to hasten the scientific discoveries in the field. In addition, scientists were required to publish papers on open access journals or platforms, free of charge for the readers, and allow the data to become publicly available in half a year following the experiments.

The virus also impacted some other activities of CERIC. For example, we prepared two papers reviewing the impact of the pandemic on analytical facilities and delivered most of the educational and outreach activities online. Even our contribution to the ESOF festival, a biennial, pan-European, general science conference in Trieste, was a hybrid one, with on-site and virtually accessible content.

While the pandemic strongly marked the year, the report highlights the many activities and achievements, which continued despite it. For example, read about the scientific achievements of our users, who discovered microplastics in the digestive tract of Antarctic animals. They also described the mechanism governing calcium-sulphur batteries and the properties of oxidised nanosheets, thus paving the way for a novel generation of efficient and cost-effective (photo-)electrocatalysis. Many other achievements are also reported, including in education, communication and industrial liaison, and our efforts aimed at better operations.

The functioning of CERIC is made possible by the considerable support from the Italian government and the in-kind contributions by our Member Countries, pooling resources to support CERIC's operations. Furthermore, our activities were supported by several of the Member Countries, the European Commission and European Structural and Investment Funds, demonstrating how such funds can be used in synergy in the activities performed by CERIC.

The last words are dedicated to my colleagues across the eight of the CERIC countries. Yes, CERIC is a research infrastructure, but it is people that make the science advance. The past year was even more demanding and challenging than the previous ones. Nevertheless, we have successfully sailed through the many reefs, mainly due to our staff and colleagues' dedication, commitment and expertise.

Thank you.

Executive Summary

The year 2020 was marked by the COVID-19 pandemic, which affected the operations of analytical facilities across the globe. Under the changed working conditions, CERIC received only marginally fewer proposals than in the previous year, while participation in policy-related activities was significantly decreased, primarily due to the smaller number of events (Table 1).

Headline Indicators	2017	2018	2019	2020	% Change 2020-2019
Proposals received	195	234	279	270	-3,3
Number of papers	37	55	85	98	15,3
Projects' funding (CERIC)	382,159.75	509,041.99	694,316.91	699,279.20	0,7
Invited participations in policy-related activities	18	14	17	12	-29,4
Share of papers among 10% top cited			13%	12%	0

Table 1 Headline indicators for 2017-2020 and changes in the last reported year.

Excellent Science

In 2020, CERIC continued to provide access to its research infrastructure and contribute to the advancement of science. Its calls for open access attracted 270 proposals, requesting the use of 377 instruments. Proposals came from 35 countries and four continents.

The COVID-19 pandemic affected the operations of the analytical facilities, since numerous research organisations were closed, which prevented users from preparing samples. In addition, travel bans prevented many users from performing the experiments at CERIC's partner facilities. CERIC responded to the changed conditions by setting up procedures for sample mailing and by supporting the enhanced use of remote access. 73% of the measurements scheduled were performed, despite the pandemic, of which 30% with remote access.

The scientific output has improved since 2019. This is reflected in the 11.4% increase in the number of scientific publications, as well as in their impact, most often expressed as the percentage of publications that are among the 10% top cited. For the second consecutive year, CERIC collected this information according to the adopted ESFRI methodology[1]. Thirteen percent of CERIC publications published in 2017-19 are among the top 10% cited publications[2].

A core activity of CERIC is also to promote the integration of its Partner Facilities, through internal research projects and research infrastructure investments bringing together at least two CERIC facilities. The activities also contribute to increasing the capabilities of CERIC, and to pooling resources across EU countries towards the same objectives.

In addition to its services supporting characterisation and modification of a large range of materials, the Outline of CERIC's science strategy and research roadmap upgrade foresees a stronger focus on the fields of Energy Materials and Life Sciences. To increase the capabilities of CERIC in the domain of battery research, CERIC appointed an external scientific advisory group of distinguished experts (Antonella Iadecola, Lorenzo Stievano and Benedetto Bozzini). Their report, published in 2020, identifies the potential of CERIC infrastructure in this domain, proposing specific upgrades better to serve this community. The ISTAC found the report excellent and valuable, as did the General Assembly, which adopted the proposed Action Plan, aimed at implementation of the proposed recommendations. It also decided to follow the same approach in the domain of fuel cells.

Monitoring the quality of CERIC's infrastructure and services continued in 2020, with a periodic evaluation of the Polish PF.

Training, Industrial Liaison, Communication, Projects

Training and up-skilling at all levels is strongly prioritised by CERIC. The PaGES5 project enabled 83 pupils from the Italian Region Friuli Venezia Giulia to access a wide programme of lectures and hands-on training. Due to the pandemic, the 2019/2020 edition took a hybrid shape, starting with face-to-face training in schools and in the labs at the CERIC synchrotron facility in Trieste (Italy) until February 2020, to shift then to an online format during the lockdown.

The scientific opportunities available in the Consortium, as well as scientific use cases of the techniques available, were presented at scientific events organized by CERIC partners, or in the frame of the A CCELERATE project.

Moreover, in 2020, CERIC launched a call for PhD grants, in collaboration with the CERIC PFs and ten universities in Austria, the Czech Republic, Italy, Romania and Slovenia. From the nineteen grants, fourteen selected candidates started their research programmes in November 2020, in fields spanning life sciences and materials sciences, energy materials and heritage science. Seven of these PhD candidates will carry out their research within the CERIC internal project Integra. The five remaining grants will start in 2021.

Throughout the year, in 2020 CERIC also continued its capacity building activity for industrial liaison and technology transfer (IL/TT) staff of its PFs and other RIs, through open online webinars carried out by international experts, with a focus on IL&TT-related topics.

In the IL domain, an agreement was signed between CERIC and the Croatian, Slovenian and Polish representing entities (REs), or the owners/hosts of the CERIC PFs, to foster the involvement of industry and contribute to their TT activities. The agreement was also presented to the other REs of CERIC and it is currently under evaluation.

In relation to industrial usage of the CERIC PFs via open access in 2020, 8% of the proposals received were – according to the users – projects with industrial interest. In terms of publications, 9% of the articles released in 2020 were related to industry.

Following the outbreak of COVID-19, a lot of effort in the communication domain was made to inform the scientific community about updates on transnational open access procedures, and to promote the call for fast-track access to the CERIC facilities for COVID-related research. In addition, a new CERIC corporate video was released and, in September 2020, CERIC contributed, in collaboration with The Association of European-Level Research Infrastructures Facilities (ERF), to the science dissemination event, ESOF 2020, with a booth at the Science in the City Festival in Trieste, Italy.

In addition to ordinary funding, CERIC also received funding for European projects, in a total amount of nearly 700,000 EUR, which is a 3% increase over 2019. H2020 projects whose implementation continued from previous years are ACCELERATE, E-RIHS, ERIC Forum and PaNOSC.

CERIC Institutional Advances and Contribution to Policies

In relation to institutional development, particular attention was devoted to CERIC's business model. CERIC's sustainability so far relies exclusively on the cash contribution of the host country Italy and in-kind contributions of its members. To minimise the risk to its sustainability, in 2019, a more sustainable model was proposed by the Executive Director to the General Assembly (GA) of CERIC, based on monetary contributions by all Members, 90% of which is to be devoted to the enhanced integration of the PFs. After a constructive discussion on the proposed model, the GA of CERIC agreed that the delegates review the proposal within their Ministries, with a possible adoption in 2021.

In the field of the development of policies, CERIC has responded to a number of higher policy objectives, such as COVID-19, European Research Area (ERA), Horizon Europe missions, and development of EOSC, through a series of publications. They were either authored by CERIC, or prepared jointly within the frame of various settings, such as the ERIC Forum, ERF, ARIE network and the PaNOSC project.

CERIC also actively contributed to the development of RIs operations in the field of in-kind contributions, and VAT and excise exemptions for ERICs, also within the frame of the H2020 E-RIHS project.

Operations and Finance

The final section of this report presents the financial and economic situation of the Consortium for the year 2020, outlined through statements presented under the accrual basis of accounting according to International Public Sector Accounting Standards.

[1]https://www.esfri.eu/sites/default/files/ESFRI_WG_Monitoring_Report.pdf

[2]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.

1

Excellent Science

Main Achievements

1. **Implementation of 2 calls for free open access**
to which 270 proposals, requesting the use of 377 instruments, were received.

2. **Proposals came from 35 countries and 4 continents**

3. **Set-up of fast-track access for COVID-related research**

4. **An 11.4% increase in the number of scientific publications**

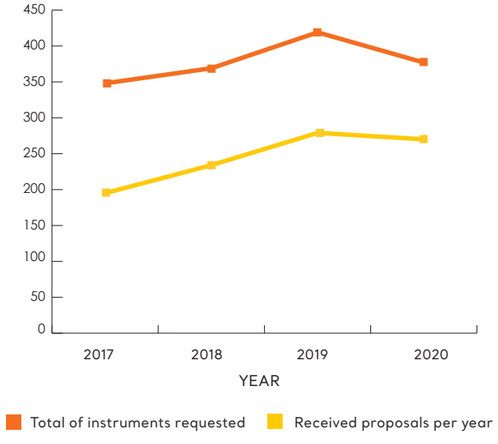
5. **Positive evaluation of the Polish CERIC Partner Facility**
by the international team of experts led by CERIC's International Scientific and Technical Advisory Committee (ISTAC).

6. **Positive evaluation of the progress of four CERIC internal research projects**

Open Access

CERIC's main aim is to enable excellent science, both as an in-house activity and as a service to international users. This is achieved mainly by providing merit-based open access to its research facilities and promoting internal research.
In 2020, CERIC launched two calls for proposals for the use of the Consortium's research instruments; 270 proposals were received (Figure 1). Given their multi-technique character, this corresponds to 377 single instrument proposals. Compared to the previous year, there was a 10% decrease in the number of applications, mostly in the autumn call. According to our surveys[1] (read more on page 39) the decrease was a consequence of the pandemic, when most countries applied limitations to the mobility and restrictions in the access to research institutes, affecting their capacity to prepare samples. These limitations forced CERIC to postpone many experiments from March 2020 to the second semester of 2020, or even to 2021.
There were 151 proposals selected, for the use of 197 allocated instruments (Figure 2). In 2020, despite the COVID-19 emergency, nearly 12,080 hours of operation were used to perform measurements, corresponding to 73% of the scheduled ones (compared to 94% in the previous year). In addition to the usual physical access (70%) to the CERIC facilities, some of them introduced the possibility of performing measurements remotely, through sample mailing. Among the submitted proposals, 33% requested access to multiple facilities, which is still a distinguishing characteristic of CERIC.

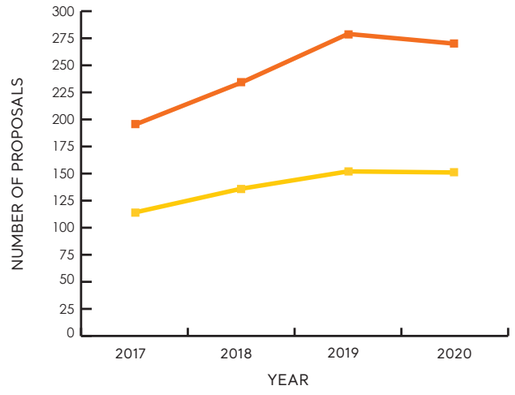
Figure 1
Number of proposals and requested methods



[1]Kolar, J., Harrison, A., Gliksohn, F., *Effect of the COVID-19 Pandemic on the Working Practices of Analytical Facilities II*, 2021, DOI: https://doi.org/10.5281/zenodo.4431748

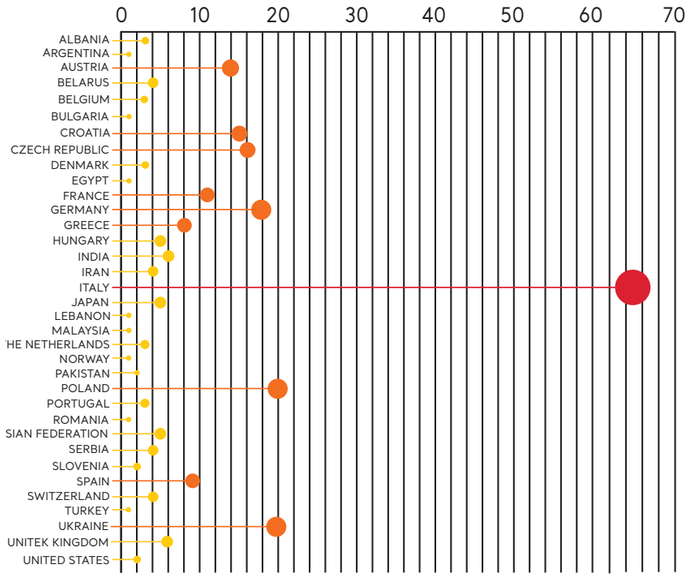
Kolar, J., Harrison, A., Gliksohn, F., *ERF's Review of Working Practices of Analytical Facilities During the Pandemic*, DOI: 10.5281/zenodo.3795659.

Figure 2
Number of received and successful proposals per year

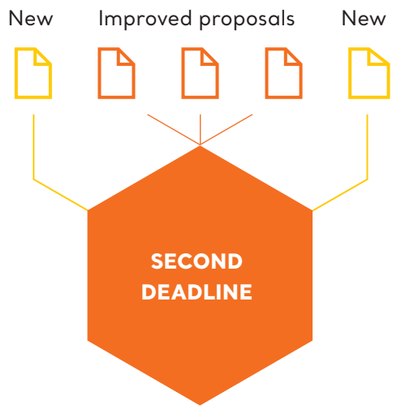


CERIC remains a highly internationalised research infrastructure, with principal investigators from 35 countries and four continents in 2020 (Figure 3). Most proposals received came from European Member States, while 49% of proposals came from non-EU countries.

Figure 3
No. of proposals by country

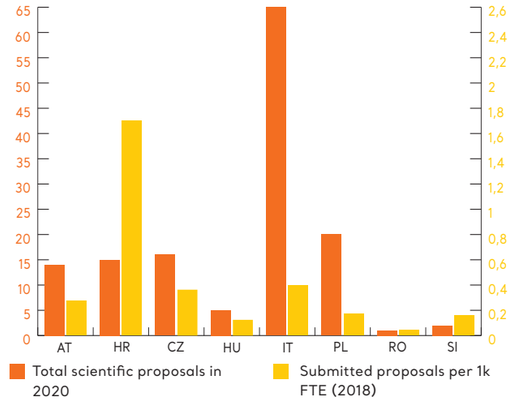


- **2 calls for proposals**
- **270 proposals received**
- **Research groups from 35 countries**
- **197 allocated requests**



The majority (52%) of submitted proposals also came from CERIC Member Countries in 2020, as in the previous year. The most active users, in relation to the fulltime employees in Research & Development in a country, are from Croatia, followed by Italy and the Czech Republic.

Figure 4
Proposals per 1K full time employees in R&D in Member Countries



In 2020, 40% of the principal investigators and 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 Output

In 2020, the number of publications stemming from measurements taken at the CERIC facilities increased by 11.4%, while the average Impact Factor (5.6) had a very slight decrease (-0.4) in comparison to the previous year. However, impact factor is a poor measure of the quality of output. As in the previous year, CERIC therefore also collected data on the most cited publications, expressed as the share of CERIC's publications among the top 10% most frequently cited ones (top10%). ESFRI[2] proposes that the indicator considers the publications over a 3-year period. The data of top10% indicator is presented in Figure 6.

Almost half (42%) of the top 10% papers were in the field of energy, followed by a quarter in life science, supporting the rationale to further focus on these two domains.

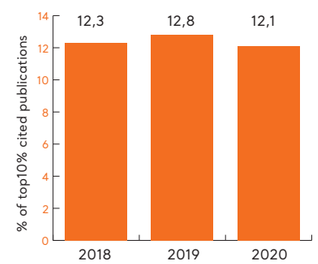


Figure 6
Percentage of CERIC papers among top 10% most cited ones, for 2018 (publications 2015-2017), 2019 (publications 2016-2018) and 2020 (publications 2017-2019).

International Scientific and Technical Advisory Committee - ISTAC

The purpose of the International Scientific and Technical Advisory Committee (ISTAC) of CERIC is to provide the General Assembly (GA) with recommendations on scientific and technical issues that bear on the full and effective utilization of CERIC as a state-of-the-art research infrastructure, and on developments required to maintain its scientific productivity at the highest possible level and ensure its relevance to the international scientific community. In particular, the ISTAC evaluates proposals for new partner facilities, and the operation of existing ones, advising the General Assembly on acceptance and continuation.

The periodic evaluation of the Polish Partner Facility (PF) was held entirely by teleconference in October 2020 (read more on page 30).

In the same year, the GA appointed Andrew Harrison as new Chair, and Luis Fonseca as new Vice-Chair, and welcomed a new member: Prof. Christoph Quitmann, Director/Head of Division Project LightHouse, RI Research Instruments GmbH.

COVID-19 Fast Track Access

At the beginning of March, at the onset of the pandemic, CERIC set up a dedicated Fast Track Access to a selected number of instruments in order to facilitate research on COVID-19.

The dedicated Fast Track Access has allowed access to a set of relevant instruments for research related to COVID-19, and this to be scheduled within one month from the submission of the proposal, based on an evaluation performed by the facility.

A wide number of techniques at the Austrian, Italian, Polish and Slovenian facilities have been devoted to the purpose, as well as the Italian Network for Micro and Nano Fabrication.

As a pilot of open access of the H2020 ACCELERATE project, all scientific information (i.e., peer-reviewed scientific research articles, and research data) generated will be made available and reusable through online access that is free of charge to the end-user.

New associated facilities

In 2020, new instruments were added to the CERIC offer: the Ultraviolet Laser Facility of the Foundation for Research and Technology – Hellas (ULF-FORTH) in Greece and the X-ray Absorption Spectroscopy beamline LISA@ESRF.

[2]ESFRI, Monitoring of Research Infrastructure Performance, Annex 5, https://www.esfri.eu/sites/default/files/ESFRI_WG_Monitoring_Report.pdf

Scientific Publications

Ninety-eight articles were published in 2020, with a cumulative impact factor of 524.5 (versus 476.8 in 2019) and an average impact factor of 5.6 (versus 6.0 in 2019):

(1) *Modelling of simultaneously obtained small and wide angle synchrotron-radiation scattering depth profiles of ordered titania nanotube thin films*, Juraić K., Plodinec M., Kereković I., Meljanac D., Mandić V., Gracin D., Janicki V., Bernstorff S., Čeh M., Hodzic A., Gajović A., Materials Chemistry and Physics, 2020

(2) *Irreversible structural dynamics on the surface of bimetallic PtNi alloy catalyst under alternating oxidizing and reducing environment*, Khalakan I., Vega L., Vorokhta M., Viñes F., Skála T., Yakovlev Y., Neyman K.M., Matolinova I., Applied Catalysis B: Environmental, 264, 2020

(3) *Effect of MgO doping on the structure and optical properties of YAG transparent ceramics*, Vorona I., Balabanov A., Dobrotvorska M., Yavetskiy R., Kryshanovska O., Kravchenko L., Parkhomenko S., Mateychenko P., Baumer V., Matolinova I., Journal of the European Ceramic Society, 40 (3), 861-866, 2020

(4) *Deactivation and selectivity for electrochemical ozone production at Ni- and Sb-doped SnO2 / Ti electrodes*, Sandin S., Hamad A.A., Cuartero M., de Marco R., Crespo G.A., Bäckström J., Cornell A., Electrochimica Acta, 135645, 2020

(5) *Phosphonate mesoporous hybrid thin films: Synthesis of organophosphosilane by thiol-ene click chemistry and applications in formation and stabilization of silver nanoparticles*, Bordoni A.V., Zalduendo M.M., Escobar A., Amenitsch H., Moya S.E., Angelomé P.C., Microporous and Mesoporous Materials, 295, 109958, 2020

(6) *Picosecond pump-probe X-ray scattering at the Elettra SAXS beamline*, Burian M., Marmiroli B., Radeticchio A., Morello C., Naumenko D., Biasoli G., Amenitsch H., Journal of Synchrotron Radiation, 27, 51-59, 2020

(7) *Morphological, optical and photovoltaic characteristics of MoSe2/SiOx/Si heterojunctions*, Silva J.P.B., Almeida Marques C., Viana A.S., Santos L.F., Gwozdz K., Popko E., Connolly L.P., Veltruskà K., Matolin V., Conde O., Scientific Reports, 10 (1), 1215, 2020

(8) *Mesoporous titania coatings with carboxylated pores for complexation and slow delivery of strontium for osteogenic inductio*, Escobar A., Muzzio N.E., Martinez-Villacorta A.M., Abarrategi A., Bindini E., Grzelczak M., Bordoni A.V., Angelomé P.C., Moya S.E., Applied Surface Science, 510, 145172, 2020

(9) *Simple Ethanol Refluxing Method for Production of Blue-Colored Titanium Dioxide with Oxygen Vacancies and Visible Light-Driven Photocatalytic Properties*, Lettieri S., Gargiulo V., Alfé M., Amati M., Zeller P., Maraloiu V.A., Borbone F., Pavone M., Muñoz-García A.B., Maddalena P., Journal of Physical Chemistry C, 2020

(10) *The boundary lipid around DMPC-spanning influenza A M2 transmembrane domain channels: Its structure and potential for drug accommodation*, Konstantinidi A., Chountoulesi M., Naziris N., Sartori B., Amenitsch H., Mali G., Čendak T., Plakantonaki M., Triantafyllakou I., Tselios T., Demetzos C., Busath D.D., Mavromoustakos T., Kolocouris A., Biochimica et Biophysica Acta – Biomembranes, 1862 (3), 2020

(11) *Exploring the role of the membrane bilayer in the recognition of candesartan by its GPCR AT1 receptor*, Kiriakidi S., Chatzigiannis C., Papaemmanouil C., Tzakos A.G., Mavromoustakos T., Biochimica et Biophysica Acta – Biomembranes, 1862 (3), 2020

(12) *Iron-Mediated Interaction of Alpha Synuclein with Raft-like Model Membranes*, Perissinotto F., Stani C., De Cecco E., Vaccari L., Rondelli V., Posocco P., Scaini D., Legname G., Parisse P., Casalis L., Nanoscale, 2020

(13) *Stable Ultraconcentrated and Ultradilute Colloids of CsPbX3 (X = Cl, Br) Nanocrystals Using Natural Lecithin as a Capping Ligand*, Krieg F., Ong Q.K., Burian M., Raino G., Naumenko D., Amenitsch H., Süess A., Grotevent M.J., Krumeich F., Bodnarchuk M.I., Shorubalko I., Stellacci F., Kovalenko M.V., Journal of the American Chemical Society, 141 (50), 19839-19849, 2020

(14) *Unravelling the surface chemistry and structure in highly active sputtered Pt3Y catalyst films for the oxygen reduction reaction*, Brown R., Vorokhta M., Khalakhan I., Dopita M., Vonderach T., Skala T., Lindahl N., Matolinova I., Gronbeck H., Neyman K.M., Matolin V., Wickman B., ACS Applied Materials & Interfaces, 12 (4), 2020

(15) *Photonic glass ceramics based on SnO2 nanocrystals: advances and perspectives*, Thi Ngoc Tran L., Armellini C., Balda R., Benabdesselam M., Berneschi S., Blanc W., Boulard B., Carpentiero A., Chiappini A., Chiasera A., Dentella P., Dorotsz D., Eaton S., Falconi M., Fernandez J., Ferrari M., Gates J., Gluchowski P., Ischia G., Lukowiak A., Mady F., Massella D., Conti G., Prudenzano F., Rossi B., Zamponi R., Richini G., Sazio P., Speranza G., Varas S., Zonta D., Zur L., Proceedings of SPIE – The International Society for Optical Engineering, 11276, 2020

(16) *Mineralogy and Zn Chemical Speciation in a Soil-Plant System from a Metal-Extreme Environment: A Study on Helichrysum microphyllum subsp. tyrrhenicum (Campo Pisano Mine, SW Sardinia, Italy)*, Maria Boi E., Medas D., Aquilanti G., Bacchetta G., Birarda G., Mappai G., Carlomagno I., Casu M., Gianoncelli A., Meneghini C., Piredda M., Podda F., Porceddu M., Rimondi V., Vaccari L., De Giudici G., Minerals, 10 (3), 2020

(17) *Combined effect of citrate and fluoride ions on hydroxyapatite nanoparticles*, Degli Esposti L., Adamiano A., Tampieri A., Ramírez-Rodríguez G.B., Siliqi D., Giannini C., Ivanvhenko P., Martra G., Lin F.H., Delgado-López J.M., Iafisco M., Crystal Growth & Design, 2020

(18) *Tailoring Morphology Compatibility and Device Stability by Adding PBDTTPD-COOH as Third Component to Fullerene-Based Polymer Solar Cells*, Yang D., Cao B., Körstgens V., Saxena N., Li N., Bilko C., Grott S., Chen W., Jiang X., Heger J.E., Bernstorff S., Müller-Buschbaum P., ACS Applied Energy Materials, 3 (3), 2020

(19) *Chemistry-dependent magnetic properties at the FeNi oxide-metal interface*, Genuzio F., Mentes O.T., Freindl K., Spiridis N., Korecki J., Locatelli A., Journal of Materials Chemistry C, 2020

(20) *Ligand binding to G-quadruplex DNA: new insights from ultraviolet resonance Raman spectroscopy*, Di Fonzo S., Amato J., D'Aria F., Caterino M., D'Amico A., Gessini A., Brady J W., Cesàro A., Pagano B., Giancola C., Physical Chemistry Chemical Physics, 2020

(21) *Shape Deformation in Ion Beam Irradiated Colloidal Monolayers: An AFM Investigation*, Lotito V., Karlušić M., Jakšić M., Luketić K.T., Müller U., Zambelli T., Fazinić S., Nanomaterials, 10 (3), 2020

(23) *Nanostructured Liquid Crystalline Particles as Delivery Vectors for Isofuranodiene: Characterization and In-vitro Anticancer Activity*, Pisani M., Quassinti L., Bramucci M., Galassi R., Maggi F., Rossi B., Damin A., Carloni P., Astolfi P., Colloids and Surfaces B: Biointerfaces, 111050, 2020

(23) *Effect of the composition of silver doped M-Si oxide systems (M: Mg, Zr, La) on their catalytic properties in the conversion of ethanol to 1,3-butadiene*, Kyriienko P., Larina O., Balakin D., Sergiienko S., Soloviev S., Theoretical and Experimental Chemistry, 56 (1), 33-38, 2020

(24) *Investigation of nano-microstructural changes in Maastricht limestone after treatment with nanolime suspension*, Ševčík R., Viani A., Mancini L., Appavou M., Machová D., Applied Physics A, 126 (5), 367, 2020

(25) *Polymorphism of human telomeric quadruplexes with drugs: A multi-technique biophysical study*, Comez L., Bianchi F., Libera V., Longo M., Petrillo C., Sacchetti F., Sebastiani F., Rossi B., D'Amico F., Gessini A., Masciovecchio C., Amenitsch H., Sissi C., Paciaroni A., Physical Chemistry Chemical Physics, 22 (29), 11583-11592, 2020

(26) *Evolution of the PtNi Bimetallic Alloy Fuel Cell Catalyst under Simulated Operational Conditions*, Khalakhan I., Bogar M., Vorokhta M., Kúš P., Yakovlev Y., Dopita M., Seale Sandbeck D.J., Cherevko S., Matolínová I., Amenitsch H., ACS Applied Materials & Interfaces, 12 (15), 17602-17610, 2020

(27) *Cigarette butts, a threat for marine environments: Lessons from benthic foraminifera (Protista)*, Caridi F., Sabbatini A., Birarda G., Costanzi E., De Giudici G., Galeazzi R., Medas D., Mobili G., Ricciutelli M., Ruello M.L., Vaccari L., Negri A., Marine Environmental Research, 162, 2020

(28) *Titanium-based potassium-ion battery positive electrode with extraordinarily high redox potential*, Fedotov S., Luchinin N., Aksyonov D., Morozov A., Ryazantsev S., Gaboardi M., Plaisier J., Stevenson K., Abukumov A., Antipov E., Nature Communications, 11, 2020

(29) *Cobalt Oxide-Supported Pt Electrocatalysts: Intimate Correlation between Particle Size, Electronic Metal–Support Interaction and Stability*, Bertram M., Prössl C., Ronovský M., Knöppel J., Matvija P., Fusek L., Skála T., Tsud N., Kastenmeier M., Matolin V., Mayrhofer K.J.J., Johánek V., Mysliveček J., Cherevko S., Lykhach Y., Brummel O., Libuda J., Journal of Physical Chemistry Letters, 8365-8371, 2020

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Scientific Highlights

Microplastics found in the Antarctic terrestrial food web[3]

Microplastics are plastic fragments below 1 millimetre in size, which can result from a variety of sources such as clothing, cosmetics, industrial processes and degradation of plastic items. They have been detected in air, water, and even in food. While their effects on human health are still under investigation, recent studies show that microplastics could affect the nervous, respiratory and digestive system, with the smallest particles capable of crossing cellular membranes. Regrettably, microplastics have been reported in almost every environment, even in remote areas such as Mount Everest and the Mariana Trench. In 2020, CERIC users presented the first evidence of microplastics in the Antarctic terrestrial food web.

Elisa Bergami

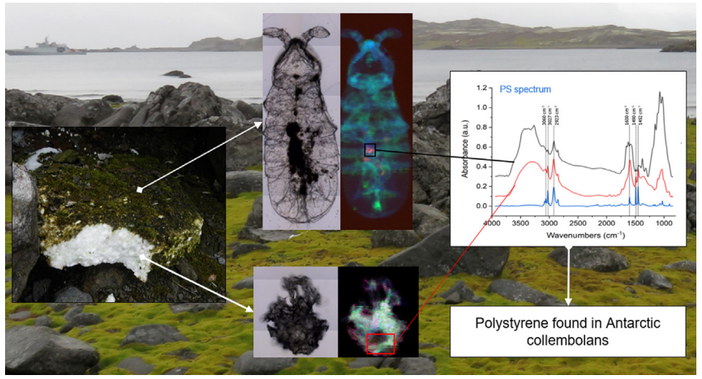


Figure 7
Graphical abstract of the study

"We demonstrated that Antarctic collembolans can ingest plastic debris. We were able to map the spectral features of their organism and to detect the polystyrene pieces inside the organism, versus the organic material. This was never performed before with environmental samples".

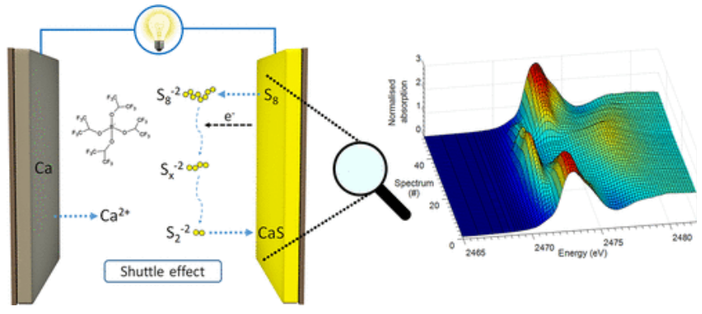
Dr. Elisa Bergami and **Prof. Ilaria Corsi**, from the University of Siena (Italy), and colleagues, started their research from a large piece of polystyrene foam found in 2016 along the shores of King George Island (South Shetland Islands), about 120 Km from the Antarctic coast. The polystyrene piece was covered in algae, moss and lichens, which feed different life forms, including a 2 millimetre small invertebrate, *Cryptopygus antarcticus*, belonging to the Collembola group (otherwise known as springtails, a key component of the terrestrial food chain all around the globe). Specimens of Antarctic collembolan were taken and analysed at the Italian CERIC partner facility at Elettra Sincrotrone Trieste, by Fourier Transform Infrared Microscopy (μ-FTIR), at SISSI beamline. The analysis of the samples, carried out with the support of **Dr. Giovanni Birarda** and **Dr. Lisa Vaccari**, showed the presence of polystyrene micro-fragments below 100 μm in the digestive tract of Antarctic collembolan. This result highlights the severe threat to the fragile Antarctic terrestrial ecosystem and implies that microplastics might have deeply entered the soil food webs even in less remote regions. Further research should investigate the ecological consequences of microplastics in soils in order to understand how extensive the threat is for the environment.

[3] *Plastics everywhere: first evidence of polystyrene fragments inside the common Antarctic collembolan Cryptopygus antarcticus*, Bergami E., Rota E., Caruso T., Birarda G., Vaccari L., Corsi I., Biology Letters, 16 (6), 2020, DOI: 10.1098/rsbl.2020.0093

Unveiled the mechanism governing calcium-sulphur batteries[4]

Lithium-ion (Li-ion) batteries are powering a large number of devices, ranging from smartphones to trucks. Currently, the demand for batteries is driven by electric vehicles (EV), sales of which appear to be further accelerating during this pandemic. Such a large, and still growing demand for energy materials raises questions about resource availability and associated geopolitical issues. Extensive research efforts are therefore aimed at a new generation of post-lithium batteries. Indeed, elements such as sodium, calcium and sulphur are cheap, readily available and can replace lithium and cobalt, which are only available in exploitable amounts in a few areas, such as Latin America and the Congo, and the cost of which may vary in the future depending on geopolitical developments.

Lorenzo Stievano



Robert Dominko

Figure 8
Graphical abstract of the study

Professors **Robert Dominko** (National Institute of Chemistry in Ljubljana) and **Lorenzo Stievano** (Institut Charles Gerhardt in Montpellier) presented a promising proof-of-concept calcium-sulphur (Ca/S) battery working at room temperature, which showed interesting features. Synchrotron light techniques, such as X-ray photoelectron spectroscopy (XPS) and X-ray absorption spectroscopy (XAS), were employed at the XAFS beamline at the Italian CERIC Partner Facility at the Elettra synchrotron in Trieste, to gather fundamental insights into the electrochemical mechanisms governing Ca/S batteries and showed encouraging results, especially considering their potential applications. A pronounced capacity fading is currently affecting the concept, but the knowledge built in this work is fundamental for improving such technology on the path toward its commercialisation. Improving our knowledge of sustainable post-lithium battery technologies will allow the change of paradigm from fossil fuels to clean energy without shifting from one problematic energy material to another.

"This achievement is the result of a multidiscliplinary research project made possible by the interaction of complementary research groups within the Alistore ERI network. We believe that our work will be a milestone in the future development of this new family of batteries".

[4] *Spectroscopic Insights into the Electrochemical Mechanism of Rechargeable Calcium/Sulfur Batteries*, Scafuri A., Berthelot R., Pirnat K., Vizintin A., Bitenc J., Aquilanti G., Foix D., Dedryvère R., Arčon I., Dominko R., Stievano L., Chemistry of Materials, 32 (19), 8266-8275, 2020, DOI: 10.1021/acs.chemmater.0c02074

Oxidised nanosheets with improved electrocatalytic performances[5]

The global demand for energy and environmental sustainability are critical challenges of this century. Photocatalysis and electrocatalysis are key processes for driving and accelerating the production of fuels, for reducing gas emission and for producing renewable energy sources. Water splitting is a crucial reaction with remarkable energy applications. Water can, in fact, be split into its constituents, oxygen and hydrogen, through fundamental photocatalytic and electrocatalytic reactions, such as hydrogen evolution (HER) and oxygen evolution (OER) reactions. Both academia and industry have shown great interest in the possibility of developing and studying new materials to boost overall energy production and enable effective energy storage, such as green hydrogen through photocatalysis and electrochemistry.

"These findings pave the way for a novel generation of efficient and cost-effective (photo-)electrocatalysis".

In research work coordinated by **Professor Antonio Politano** from the University of L'Aquila, the oxidation of nanosheets of gallium selenide (GaSe) and indium selenide (InSe) was tested by both experiments and theory, with relevant innovative features. In fact, their exfoliation in atomically thin layers enhances their performance in electrochemistry and photocatalysis. Experiments showed that the increase in performance does not originate from an increase in the surface-to-volume ratio, but rather from the formation of a thin oxide skin, which represents the catalytically active interface.

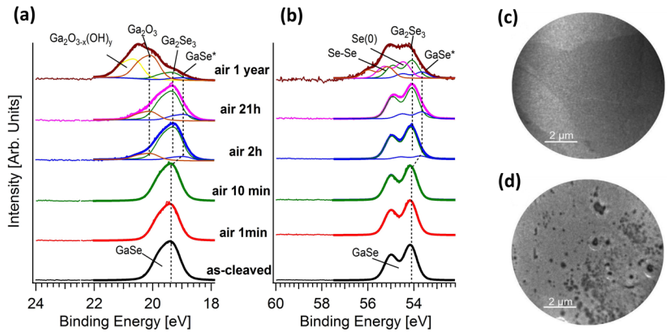


Figure 1. XPS spectra of (a) Ga 3d and (b) Se 3d core levels from GaSe exposed to air. LEEM images of (c) as-cleaved GaSe and (d) after 40 days in air.

Figure 9
XPS spectra of (a) Ga 3d and (b) Se 3d core levels from GaSe exposed to air. LEEM images of (c) as-cleaved GaSe and (d) after 40 days in air.

Among the experimental techniques employed in this research, there is the Low-Energy Electron Microscopy (LEEM), available at the Nanospectroscopy beamline of the Italian CERIC partner facility in Trieste, the Elettra synchrotron.

These findings pave the way for a novel generation of efficient and cost-effective (photo-)electrocatalysis.

[5] *Enhanced Electrocatalytic Activity in GaSe and InSe Nanosheets: The Role of Surface Oxides*, D'Olimpio G., Nappini S., Vorokhta M., Lozzi L., Genuzio F., Menteş T.O., Paolucci V., Gürbulak B., Duman S., Ottaviano L., Locatelli A., Bondino F., Boukhvalov D.W., Politano A., Advanced Functional Materials, 2020, DOI: 10.1002/adfm.202005466

Investigation of the structural dynamic of a bimetallic PtNi alloy catalyst under operational conditions[6]

Fuel cells, together with batteries, play an important role on the path towards the green energy transition. Proton Exchange Membrane Fuel Cells (PEMFC) are a shining example in a variegated landscape, due to features such as high energy density and low operational temperature. However, the catalyst is still the most challenging component, and since it is most commonly made of platinum, research is focused on platinum's substitution or usage reduction. An example in this direction is the employment of bimetallic alloy catalysts in which platinum (Pt) is combined with a low-cost transition metal, such as nickel (Ni).

"We obtained useful insights on the surface chemistry of PtNi alloy fuel cell catalyst under its working environment".

Research led by **Dr. Ivan Khalakhan** and coordinated by **Prof. Iva Matolínová** (Charles University of Prague), with the collaboration of **Prof. Konstantin Neyman** (ICREA & University of Barcelona), and colleagues, investigated phenomena that occur at the surface of a PtNi bimetallic cathode catalyst under altering oxidation-reduction environments, revealing its behaviour during operation.

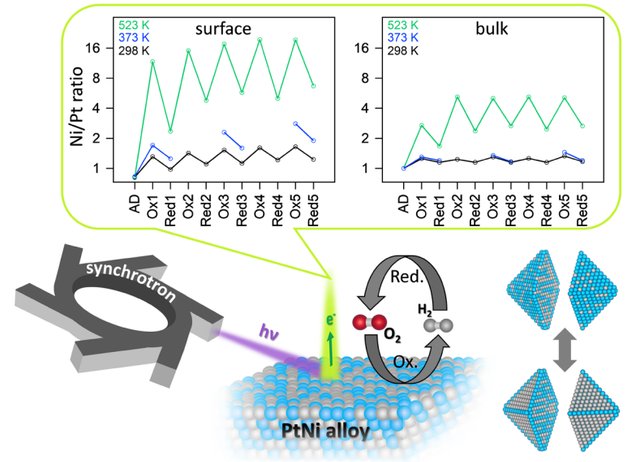


Figure 10
Schematic representation of the experiment together with results shoving oscillatory behaviour of PtNi composition in response to altering oxidation and reduction environments.

Two experimental techniques, the surface-sensitive SRPES (Synchrotron Radiation Photoelectron Spectroscopy) and the bulk-sensitive XPS (X-ray Photoelectron Spectroscopy), available at the Czech CERIC Partner Facility at Elettra Synchrotron (Material Science Beamline) were employed for samples characterisation. The experimental results, coupled with theoretical calculations, revealed that under repetitive oxidation/reduction cycles, there is an oscillatory behaviour of the surface composition of the catalyst, which led to a loss of its chemical integrity in terms of nickel surface enrichment. The enrichment of Ni species on the surface suppresses valuable properties of the PtNi alloy, which is critical for its high electrocatalytic performance.

This work provided relevant insights that will help to formulate a comprehensive model of catalyst degradation under real conditions and develop a corresponding mitigation strategy leading towards a more robust catalyst for energy systems with long-lasting performances.

[6] *Irreversible structural dynamics on the surface of bimetallic PtNi alloy catalyst under alternating oxidizing and reducing environments*, Khalakan I., Vega L., Vorokhta M., Viñes F., Skála T., Yakovlev Y., Neyman K.M., Matolinova I., Applied Catalysis B: Environmental, 264, 2020, DOI: 10.1016/j.apcatb.2019.118476

Structural investigation of borosilicate glasses for long-term immobilisation of high-level radioactive wastes[7]

There were 109 active nuclear power plants on the territory of the European Union in 2020. The spent nuclear fuel produced by each one of these plants needs to be treated in a process called reprocessing. High-level radioactive waste materials are made during this process, containing uranium, plutonium and minor concentrations of other elements of the group of actinides, such as thorium, neptunium, americium and curium. Uranium and plutonium can be converted into a mixed oxide material, which is still a usable nuclear fuel, but other long-lived actinide elements need further treatment for long-term storage in an inert host material. Borosilicate glasses are a prime candidate for this, due to their mechanical and chemical durability for high-level radioactive waste immobilisation.

Margit Fabian

A study published in Nature Scientific Reports led by Dr. **Margit Fabian** (Centre for Energy Research) focuses on the structural investigation of borosilicate glasses to incorporate lanthanides ions as a non-radioactive surrogate for actinides. The substitution of ions from the actinides to the lanthanide group of the periodic table was necessary to manipulate the samples in standard laboratory environments. This work stemmed from collaboration between the Centre for Energy Research in Budapest, the National Institute of Chemistry in Ljubljana and the Bhabha Atomic Research Centre in Mumbai.

"The results show the formulation of new lanthanide-borosilicate glasses, not only widening scientific knowledge of their structure, but also providing a stable matrix, opening a promising way to radioactive waste immobilization".

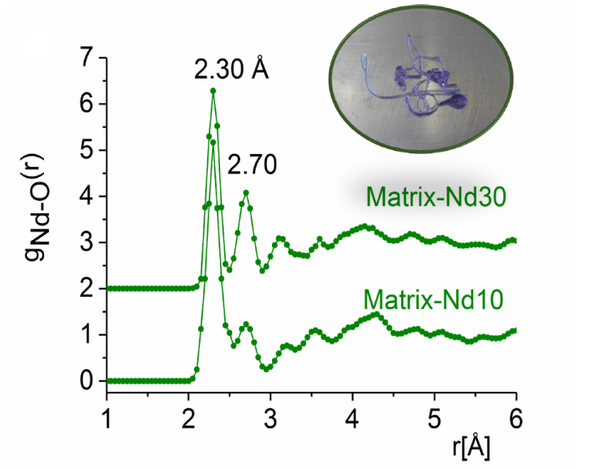


Figure 11
Graphic description of the presented study, from bulk to atomic level, with simulation of neutron diffraction data

Various experimental techniques were employed to determine the structure of lanthanide borosilicate glasses, together with computational simulations. The experiments also involved CERIC techniques such as neutron diffraction, performed at the Hungarian CERIC Partner Facility at the Budapest Neutron Centre and Magic Angle Spinning (MAS) NMR spectroscopy at the Slovenian CERIC Partner Facility at the SloNMR Centre in Ljubljana. This study allowed the conclusion that borosilicate glass matrices have a great potential for high-level radioactive waste management due to their capacity to incorporate large concentrations of actinides, thus tackling one of the main issues connected to the use of nuclear energy.

[7] *Structural investigation of borosilicate glasses containing lanthanide ions*, Fabian M., Gergely F., Osan J., Cendak T., Kesari S., Rao R., Scientific Reports, 10 (1), 2020, DOI: 10.1038/s41598-020-64754-2

Unravelling the molecular structure, self-assembly and light-manipulating properties of a cephalopod protein variant[8]

Reflectins are a family of structural proteins that are known to contribute to the dynamic coloration of cephalopods, such as the squid shown in F**igure 1A**. These proteins have caught the attention of both scientists and the public because of their role in the colour-changing capabilities of cephalopods and their potential technological applications in electronics, optics and medicine. As examples, reflectins have been used to fabricate chemically and electrically actuated colour-changing devices and dynamic near-infrared camouflage platforms. However, understanding the structure of these proteins was previously hindered by their intrinsic physical properties, such as their extreme sensitivity to subtle changes in the environmental conditions and strong propensity towards aggregation.

In a study coordinated by Prof. **Alon Gorodetsky** (University of California, Irvine), researchers determined the molecular structure of a reflectin variant, established a precise method of controlling the variant's self-assembly and revealed a direct correlation between the protein's structural characteristics and its optical properties. This scientific work was the result of a large coalition of scientists from across the world, including scientific institutions based in the USA (University of California, Irvine and North Carolina State University), Slovenia (National Institute of Chemistry), Austria (Graz University of Technology) and Italy (Elettra Sincrotrone Trieste).

Alon Gorodetsky

"Through our synergistic computational and experimental approaches, we were able to elucidate the 3D structure of the reflectin variant, thereby establishing a direct correlation between the protein's structural characteristics and intrinsic optical properties. This research can be viewed as a valuable conceptual framework for using this class of proteins in bioengineering applications".

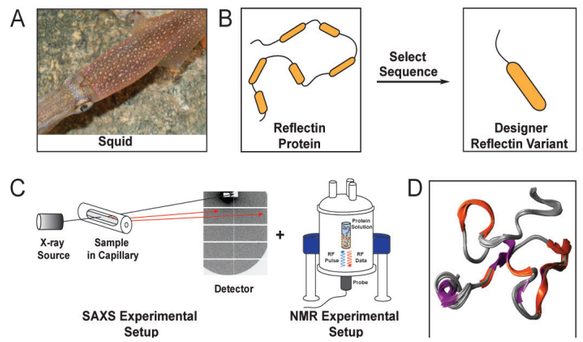


Figure 12
(A) A camera image of a D. pealeii squid. **(B)** An illustration of the selection of the prototypical truncated reflectin variant (RfA1TV) from full-length D. pealeii reflectin A1. **(C)** An illustration of the SAXS analysis of the reflectin variant in solution, wherein incident X-rays are scattered by the solution-borne protein to furnish a corresponding scattering pattern and the NMR analysis of the reflectin variant in solution, wherein the protein is probed with radio frequency pulses in a uniform magnetic field. **(D)** The 3D structure of RfA1TV in solution (random coils – gray, helices – orange, ß-strands – purple). This figure has been adapted from M. J. Umerani*, P. Pratakshya* et al. Proc. Natl. Acad. Sci. U.S.A 117, 32891-32901 (2020).

The research started with an analysis of the amino acid sequence of reflectins from several cephalopod species in order to define a reflectin variant to analyse further (**Figure 1B**). Having defined the reflectin variant, its shape and folding state were determined by Small Angle X-ray Scattering (SAXS) experiments performed at the Austrian CERIC Partner Facility, while its dynamic 3D structure was determined by 2D and 3D NMR experiments performed at the Slovenian CERIC Partner Facility (**Figure 1C**). The results obtained from the aforementioned analyses, and complementary data from several biophysical techniques, led to the elucidation of the protein's molecular structure (**Figure 1D**).
This work advances current knowledge of reflectins on multiple distinct fronts, from a better understanding of the mechanisms that enable cephalopods' camouflage abilities to unlocking the potential of reflectins as a structurally tuneable material for applications spanning biochemistry, cell biology, bioengineering and optics.

[8] *Structure, self-assembly, and properties of a truncated reflectin variant*, Umerani M.J., Pratakshya P., Chatterjee A., Cerna Sanchez J.A., Kim H.S., Ilc G., Kovačič M., Magnan C., Marmiroli B., Sartori B., Kwansa A.L., Orins H., Bartlett A.W., Leung E.M., Feng Z., Naughton K.L., Norton-Baker B., Phan L., Long J., Allevato A., Leul-Cruz J.E., Lin Q., Baldi P., Bernstorff S., Plavec J., Yingling Y.G., Gorodetsky A.A., Proceedings of the National Academy of Sciences of the United States of America, 117 (52), 32891-32901, 2020, DOI: 10.1073/pnas.2009044117

A new production route for MOFs as supported films and self-standing membranes with an impact on battery performances[9]

Metal-organic frameworks are a class of compounds with unique properties and various applications, including gas storage, separation, catalysis, biotechnology, optics, microelectronics, energy production and storage. Each application has its own requirements in terms of the shape and functionality required. For instance, bulk powders are preferable for gas storage, while other applications require supported films or self-standing membranes.
An international team of scientists from the Australian National University, Graz University of Technology, the University of Texas at Austin, and the Centre for Membrane Separations in Belgium reported a strategy for the fabrication of MOFs films and self-supporting membranes with tuneable porosity and thickness ranging from nano- to milli-metre range.
The study was directed by Prof. **Antonio Tricoli** at the Australian National University with the collaboration of Professors **Paolo Falcaro** and **Heinz Amenitsch** from the Graz University of Technology, and colleagues. Small Angle X-ray Scattering, available at the Austrian CERIC partner facility at Elettra Sincrotrone Trieste, and supervised by Prof. Amenitsch, is among the experimental techniques employed in this study.


Antonio Tricoli

"The feasibility of using ultra porous networks of nanoparticles, made by aerosol deposition, as a precursor for MOFs enables the rapid and scalable fabrication of sophisticated MOF shapes with controllable thickness from few nanometres to hundreds of micrometres over very large surfaces. This is an important step toward the integration and use of MOFs for several devices, including high energy density Li-S batteries".

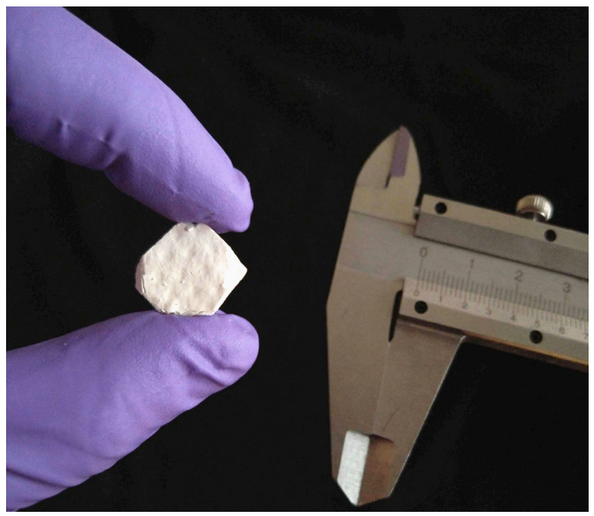


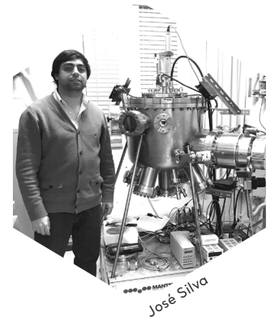
Figure 13
The image shows a square of ZIF-8 MOF of 1x1 cm2 and thickness of several hundred micrometers cut out of a larger MOF membrane that was fabricated by dry conversion of ultraporous ZnO nanoparticle networks made by aerosol deposition.

Scientists successfully coated different surfaces, such as a needle, a ceramic milling ball and flexible aluminium foil. In addition, in order to test further the performance of this production route, self-standing membranes were tested as battery separators, since MOF membranes display selective ion conductivity. The test was realised with a model Lithium-Sulphur (Li-S) battery, and the self-standing membrane acted as an effective separator by allowing Li+ transport and blocking the polysulfide species. These tests highlighted a significantly reduced battery fading among cycles, a meaningful property towards the development of new generation batteries. This result confirms once again the great flexibility of MOFs technology.

[9] *Hierarchical Metal-Organic Framework Films with Controllable Meso/Macroporosity*, Bo R., Taheri M., Liu B., Ricco R., Chen H., Amenitsch H., Fusco Z., Tsuzuki T., Yu G., Ameloot R., Falcaro P., Tricoli A., Advanced Science, 7 (24), 2020, DOI: 10.1002/advs.202002368

High-energy storage performance achieved in ZrO_2 film-based capacitors[10]

The pressing demands for the green energy transition are pushing the research agenda to develop advanced solutions for the future of energy storage. Alongside batteries, capacitors can also be used for energy accumulation but, while batteries rely on chemical energy, capacitors work by electrostatic energy. Capacitors are also characterised by small volumes, fast charge/discharge, and are not subject to capacity fading over time, although batteries have a much larger storage density.


José Silva

Dr. **José Pedro Basto da Silva** (University of Minho, Portugal) with the collaboration of Prof. **Koppole Sekhar** (Central University of Tamil Nadu, India), Dr. **Haribabu Palneedi** (Pennsylvania State University, USA), and co-authors, reported for the first time the employment of ferroelectric ZrO_2 films as energy storage capacitors. The authors also assessed the effect of different thicknesses of a low permittivity dielectric HfO_2:Al_2O_3 (HAO) layer on the energy storage performance of the ZrO_2 film capacitors.

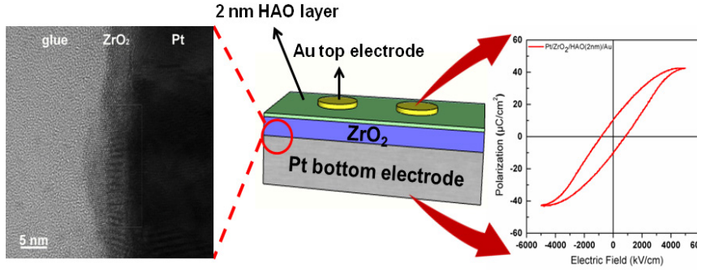


Figure 14
Ferroelectric performance of Pt/ZrO_2/HfO_2:Al_2O_3(HAO)/Au film capacitor.

The crystalline nature of ZrO_2 films was investigated by High-Resolution Transmission Electron Microscope (HRTEM) at the Romanian CERIC Partner Facility at the National Institute of Materials Physics with the supervision of Dr. **Corneliu Ghica**. HRTEM and other experimental procedures demonstrated that energy storage performance could be tuned by controlling the HAO layer's thickness. Best performances in terms of storage efficiency and energy density were obtained with a 2 nm-thick HAO layer.

This work proved that high-energy storage performances could indeed be achieved by simple binary oxides such as ZrO_2 films with ferroelectric behaviour, as a potential alternative to Pb-based and Pb-free ceramics with complex compositions. The development of different energy technologies is of paramount importance to provide energy for various devices and machinery.

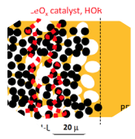
"In this work, orthorhombic ZrO_2 thin films, with a $Pca2_1$ space group, were fabricated by ion beam sputter deposition technique. A 55% energy storage density improvement was achieved via coupling with a dielectric layer and an optimum combination of high energy density of 54.3 J cm^{-3} and good storage efficiency of 51.3% are obtained for ZrO_2 film capacitors with a 2 nm-thick HAO insert layer".

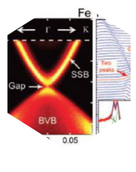
[10] *Energy storage performance of ferroelectric ZrO_2 film capacitors: Effect of HfO_2:Al_2O_3 dielectric insert layer*, Silva J.P.B., Silva J.M.B., Sekhar K.C., Palneedi H., Istrate M.C., Negrea R.F., Ghica C., Chahboun A., Pereira M., Gomes M.J.M., Journal of Materials Chemistry A, 8 (28), 14171-14177, 2020, DOI: 10.1039/D0TA04984K

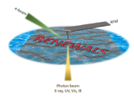
Internal Research Projects

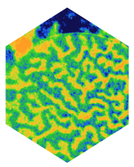
The four projects selected within the frame of the 2016 Call for Research Grants and kicked-off in 2017, continued their implementation in 2020. Funding has been allocated by CERIC each fiscal year starting 2017, subject to a positive outcome of the yearly progress evaluation made by ISTAC. The overall contribution of MIUR for the abovementioned projects amounts to € 1,750,530. The partners have contributed in-kind a total amount of € 5,659,474. The CEROP project is the first of the CERIC grants to conclude the research programme, which was positively assessed by the ISTAC of CERIC in October 2020.
The goal of these projects is to foster the integration of national multidisciplinary facilities into a unique EU-level distributed research infrastructure. They also aim to contribute to the scientific excellence of the staff, to increase CERIC capabilities and to pool resources across EU countries towards the same objectives.

The following projects have been funded:
CEROP (Deciphering single-atom catalysis in Pt/ceria systems via advancing the CERIC operando methods) aimed at developing in-operando experimental methods to study the process of heterogeneous catalysis under realistic conditions. This enabled a deeper insight into catalysis and helped in designing more efficient catalysts.
Dyna Chiro (Spectroscopy and Dynamics of Chiral Systems) focuses on the development and construction of special synchrotron-suitable instrumentation to investigate the chiral and dynamic properties of matter. The results of this investigation have a wide range of applications, from synthesis of new polymers to drug design.
RENEWALS (Graphene for Water in Life Sciences) addresses the growing issue of possible toxic and physiological effects of nanoparticles. The basis of the project is the development of graphene-based liquid cells for multi-technique analysis of hydrated cellular samples and their interactions with nanoparticles.
MAG-ALCHEMI (Magnetic Anisotropy Grafting by Means of Atomic Level Chemical Engineering at Film Interfaces) focuses on magnetic materials and aims at developing tools to control thin magnetism via interfacial engineering.
The main goal is to devise novel means of tuning the magnetic state of matter by appropriately modifying the interface chemistry, towards further developments in the architecture and performance of various devices.









The progress of all projects was positively evaluated by the International Scientific and Technical Advisory Committee of CERIC in 2020. Dyna Chiro, RENEWALS and MAG-ALCHEMI were extended due to difficulties in the execution caused by the pandemic.

Another CERIC internal research project is "**Nanoanalytics for Pharmaceutics**", with Dr. **Aden Hodzic** as principal investigator. In the project, various nano-analytical techniques are used to develop drug formulations and release them in solid, liquid-crystal and liquid states, enclosed in active pharmaceutical ingredients (APIs). The work implements a methodology based on nano-analytics, which predicts the dissolution and structural properties of tested drugs in a time range of minutes. Once applied, the research will impact the therapeutic performance of nano-systems.

Improved nanoparticles towards more effective drug formulation, delivery and cancer treatment[11]

A study conducted within the frame of the **Nano-analytics for Pharmaceutics** project led by **Aden Hodzic** (CERIC-ERIC) and in cooperation with UCL scientists **Maximilian Besenhard**, **Nguyen Thi Kim Thanh**, and **Asterios Gavriilidis**, sheds light on new methods for the synthesis of iron oxide nanoparticles. The findings will help improve future drug formulation and delivery for more effective cancer diagnosis and treatment.
Magnetic iron oxide nanoparticles (IONPs) have emerged as one of the primary nanomaterials in biomedicine, thanks to their low toxicity and biodegradability. Their morphological features allow their use in drug delivery systems for tumour cells imaging or burning, as well as for delivery of therapeutic agents. For example, they can be used as contrasting agents for magnetic resonance imaging (MRI), which is widely deployed in clinical oncology diagnostics.
However, iron oxide nanoparticles are unstable from a physical-chemical point of view. This is because they tend to agglomerate and oxidize, increasing the risk of toxicity for the body, and of side effects if used in the clinical field. Their use for clinical and medical purposes therefore requires an in-depth investigation of all the phases necessary for their synthesis, for a more complete understanding of the mechanisms that drive their formation.
The synthesis of nanoparticles is challenging, due to the high speed in which they form (a few seconds), which reduces the time available to analyse their characteristics. The approach adopted by the researchers has overcome this limitation through the use of a new application method of a continuous flow reactor, for the observation of the single states of the reaction in real time. This allowed us to analyse the nanoparticles in their transient reaction states, as if they were “frozen” in single frames. This method allowed, for the first time, the study of the first phases of formation of the solid particles obtained from a liquid solution (i.e., so-called, co-precipitation). The addition of citric acid to the first precipitates of particles has also shown its effectiveness in giving them greater stability.


Aden Hodzic

"One of the added values of the ‘Nano-analytics for Pharmaceutics’ project is the use of multiple complementary advanced techniques to solve complex problems towards more efficient cancer diagnosis and treatment. In the next steps, we plan to build and study magneto-liposomes as a new kind of nano-drug delivery system".

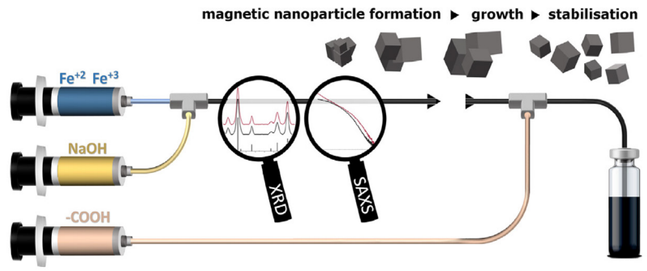


Figure 15
Graphical abstract of the study

Thanks to the information obtained with X-ray diffraction and Small-Angle X-ray diffraction techniques, on the formation and stabilisation of nanoparticles, it has been possible continuously to synthesise stable iron oxide nanoparticles, which demonstrates the efficiency of the innovative synthetic procedure used.
“*One of the added values of the ‘Nano-analytics for Pharmaceutics’ project is the use of multiple complementary advanced techniques to solve complex problems towards more efficient cancer diagnosis and treatment*” – said Hodzic. In this respect, methods using high resolution synchrotron light and laboratory techniques provided by CERIC-ERIC allowed a closer look at nanoparticles structure and to the intermediate stages of their synthesis.

[11] *Co-Precipitation Synthesis of Stable Iron Oxide Nanoparticles with NaOH: New Insights and Continuous Production via Flow Chemistry*, Basenhard M.O., LaGrow A.P., Hodzic A., Kriechbaum M., Panariello L., Bais G., Loizou K., Damilos S., Margarida Cruz M., Thi Kim Thanh N., Gavriilidis A., Chemical Engineering Journal, 125740, 2020, DOI: 10.1016/j.cej.2020.125740

CERIC scientists look into details of the degradation of bimetallic alloy catalysts[12]

A fuel cell is a device that converts the chemical energy of a fuel into electricity without burning it. Together with batteries, they represent a relevant alternative for the future of energy and mobility. Among the many technologies developed over the years, Proton Exchange Membrane Fuel Cells (PEMFC) have gathered much attention for their interesting features, such as high power density and low operational temperatures.

The catalyst is a fundamental component of PEMFC. However, being mostly made of platinum, it also represents a challenge. Nowadays, much effort is devoted to the substitution of platinum, or the minimisation of its employment. The work of CERIC's internal research project **CEROP** follows this purpose.

The study, led by **Dr. Ivan Khalakhan** (Charles University of Prague) and **Prof. Heinz Amenitsch** (Graz University of Technology), in collaboration with **Marco Bogar** (CERIC-ERIC), **Serhiy Cherevko** (Forschungszentrum Jülich GmbH) and colleagues, has highlighted the behaviour of a fuel cell catalyst made of an alloy of platinum and nickel (PtNi). In this case, the costs are lower, but durability under operational conditions becomes an essential factor.

The study revealed the correlation between the upper potential limit during potentiodynamic cycling, which is a different fuel cell operation regime, and the structural behaviour of the PtNi catalyst, by employing state-of-the-art *in situ* techniques, including grazing-incidence small-angle X-ray scattering (GISAXS) and Atomic Force Microscopy (AFM), available respectively at the Austrian and Czech Republic CERIC Partner Facilities. AFM was used to explore microscopic processes involved in the degradation of the catalyst, while GISAXS investigated the structural changes at the interface (parallel and perpendicular to the surface) between 1 and 100 nanometres.

The study showed that at lower upper potentials (0,6 and 1 V), the catalyst keeps its morphology during the entire cycling procedure. In contrast, dramatic changes occur in the structure at higher upper potentials (1,3 and 1,5 V). In the latter condition, nickel dissolution took place rapidly at early stages of cycling, which is substituted by catalyst coarsening at later stages. The latter phenomenon identifies the growth of the mean particle size driven by the reduction in particle boundary area.

The use of well-defined conditions and sensitive *in situ* experiments revealed detailed information about the degradation of bimetallic alloy catalysts, providing valuable insights. The GISAXS technique offers new possibilities for experimental investigations, not only for fuel cell technology but also for batteries, supercapacitors or electrochemical processes on electrode surfaces in general, in which detailed structural information is essential.


Ivan Khalakhan

"We used a combination of unique *in situ* techniques to reveal detailed information about PtNi bimetallic alloy degradation under simulated operating conditions relevant for a real PEMFC device".

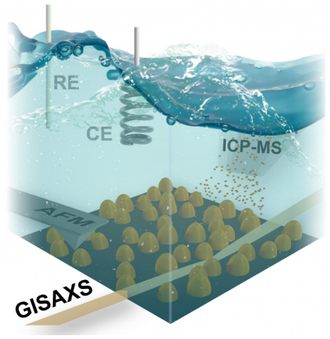


Figure 16
Illustrative image of the experimental procedure.

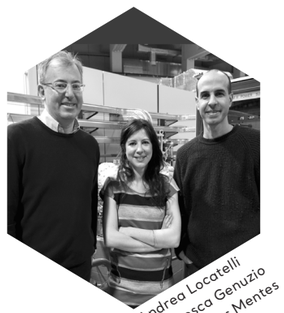
[12] *Evolution of the PtNi Bimetallic Alloy Fuel Cell Catalyst under Simulated Operational Conditions*, Khalakhan I., Bogar M., Vorokhta M., Kúš P., Yakovlev Y., Dopita M., Seale Sandbeck D.J., Cherevko S., Matolínová I., Amenitsch H., ACS Applied Materials & Interfaces, 12 (15), 17602-17610, 2020, DOI: 10.1021/acsami.0c02083

Engineering magnetic coupling through the interface structure and chemistry[13]

The ever-growing role of Information and Communication Technology (ICT) in modern life demands memory devices offering fast access, increased space and reduced energy consumption. The discovery of giant magnetoresistance in 1988 caused a revolution in storage technology, giving birth to the novel field of spintronics. At variance with simple electronics, a spintronic device uses both the electron spin and charge to transfer and store data. Spintronic devices such as the spin valve exploit the change in electrical resistance caused by the alignment of the magnetisation in thin layers of ferromagnetic, antiferromagnetic and non-magnetic materials.

CERIC internal research project MAG-ALCHEMI focuses on the atomic-scale engineering of magnetic metamaterials, a key factor in technological transition. The project, led by Dr. **Andrea Locatelli** (Elettra Sincrotrone Trieste), has resulted in a series of publications, including a research paper on the chemistry-dependent magnetic properties at the oxide-metal interface on an iron (Fe)-nickel (Ni) alloy film. This potential candidate for a spin valve, a typical building block for a spintronic device, is composed of the most abundant metals on Earth, thus representing a sustainable choice. The mentioned work shows that the spontaneously formed oxide-metal interface in Fe-Ni alloy films has the ingredients for being put to use in such magnetic stacks.

Dr. **Francesca Genuzio** (CERIC-ERIC) and colleagues, in collaboration with the Jerzy Haber Institute of Catalysis and Surface Chemistry in Kraków (Poland), has been working on novel principles for engineering structure and chemistry-dependent magnetic coupling at interfaces consisting of Fe, Ni and their oxides. The spectroscopic photoemission and low-energy electron microscopy (SPELEEM) technique, available at the Nanospectroscopy beamline at the Italian CERIC Partner Facility at Elettra, was employed to study the partial oxidation of Fe-Ni alloy ultrathin films forming a magnetic oxide, termed a *ferrite*, which is naturally stable in ambient conditions.


Andrea Locatelli
Francesca Genuzio
Tevfik Onur Mentes

"The paper describes the realisation a cost-efficient magnetic metal/oxide nanostructure of high crystalline quality, giving practical guidelines for the realization of new generation magnetic memories".

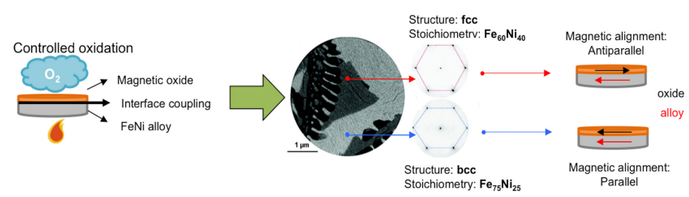


Figure 17
The image shows the key aspects of the paper published. Thermal oxidation of FeNi alloy composed by islands of two crystallografic phases (visible in the microscopic image) produces a magnetic oxide layer on top of the metallic substrate. The orientation of the magnetic domains of the oxide is either parallel or antiparallel in respect to the one in the metallic layer, depending its crystal phase.

This study demonstrated that the stoichiometry and crystalline structure of the pristine Fe-Ni phase influences not only the oxidation kinetics and the thickness of the oxide layer, but also the magnetic coupling between the metallic alloy film and the oxide overlayer. Ultimately, the result was a cost-efficient magnetic metal/oxide hetero-junction of high crystalline quality, thus giving concrete guidelines for optimizing a FeNi-based "spin-valve" based on the appropriate choice of the alloy phase.

[13] *Chemistry-dependent magnetic properties at the FeNi oxide-metal interface*, Genuzio F., Mentes O.T., Freindl K., Spiridis N., Korecki J., Locatelli A., Journal of Materials Chemistry C, 2020, DOI: https://doi.org/10.1039/D0TC00311E

Infrastructure Evaluation and Upgrade

ISTAC's evaluation of CERIC's Polish PF

With the support of ISTAC, CERIC conducts a periodical evaluation of its Partner Facilities (PFs).
The scope is to assess their performance in terms of the quality of their scientific activities and their contribution to the common strategic objectives, purposes and access capabilities of CERIC. Another goal is to appraise the added value for the facilities, of their inclusion in CERIC. In October 2020, the periodic evaluation of the Polish PF, the National Synchrotron Radiation Facility SOLARIS in Krakow, took place. Due to the COVID-19 pandemic, it was held entirely by videoconference.
Marek Stankiewicz, director of the Polish PF, presented a report on the performance and development of the PF, to the Committee of Evaluators (CoE) composed of ISTAC members **Salvador Ferrer, Andrew Harrison**, **Christoph Quitmann**, **Guy Schoehn** and **Michel Van der Rest**[13], who gave an overall positive assessment of SOLARIS and its achievements so far.
SOLARIS is a recent facility and started to offer access via CERIC's call for proposals in spring 2018. The positive response to the calls for proposals of the user community, which have applied in significant numbers since the first call, attests to its attractiveness and relevance for CERIC and for the international community. Applicants came from 15 countries worldwide, and more efforts will be made further to increase the share of the international user base. The upgrades of the facility, which allowed increased beam availability of 22h per day, 5 days per week, have positively contributed to this trend, and the ambitious plan of expansion of the capacities, through the addition of several beamlines and end-stations, is considered very relevant for CERIC. If added to its offer, the new instruments will significantly strengthen CERIC's capability in its key strategic areas of energy and health, thus further contributing to its attractiveness.
The development of the Cryo-EM, added to the CERIC offer in mid-2019, was positively noted, with the recommendation that continuous upgrades of the detector and access to local storage and computing resources be planned for the facility to remain competitive.
The CoE was also impressed by the fact that the CERIC experiments led to the publication of five scientific articles in peer-reviewed, ISI listed journals, with an average Impact Factor of 5, which is significant, considering the usual time-lag between an experiment and publications[14].
In addition, 90% of the users responding to the user satisfaction survey evaluated the performance of the instruments as very satisfactory, and all respondents considered the support given by the facility to be very satisfactory.
Finally, the CoE welcomed that SOLARIS perceives the added value of CERIC in contributing to its scientific excellence, experience and know-how, not only in science but also in communication and promotion, management, and cooperation with industry. This partnership also facilitates access to other CERIC instruments by Polish users, which was made possible even following the breakout of the pandemic, during which the facility joined CERIC's COVID-19 fast track access, with the Cryo-EM significantly contributing to the success of the initiative.

[13]Salvador Ferrer (associate director of Alba Synchrotron Light Source in Barcelona), Andrew Harrison (CEO at Diamond Light Source), Christoph Quitmann (Director / Head of Division Project LightHouse, RI Research Instruments GmbH), Guy Schoehn (IBS, Institute de Biologie Structurale in Grenoble), Michel van der Rest (former director of synchrotron SOLEIL).
[14]Impact factor of the journals is a very poor proxy for the quality of the science, however, the citations cannot yet be used due to the fact that the papers have only been published recently.

INTEGRA project

INTEGRA is a CERIC two-year internal project (with Heinz Amenitsch as principal investigator). It kicked-off in 2020 and is running until April 2022. It aims at reinforcing, enlarging and better integrating the offer of CERIC's Partner Facilities in the field of Life Sciences, covering a wide range of biological targets, from molecules to tissues and organisms.
With reference to these, the INTEGRA project has been formulated around three pillars: the nanostructural level (i.e., techniques probing atoms/proteins), the cell level and the tissue/animal/human levels, with the final goal being to promote the potential overlap of the various techniques of CERIC. This undertaking will extend CERIC-ERIC's offer in the life sciences domain, also in view of the set-up of an integrated Cryo-electron microscopy (Cryo-EM) platform in the region, which will include entry/medium level instruments in Ljubljana, as well as a top-of- the-range microscope at SOLARIS (Krakow).

The proposed upgrade of the instrumentation within INTEGRA involves seven beamlines/laboratories located in three different CERIC representing entities. The upgrades in 2020 were:

- **Elettra - Sincrotrone Trieste S.C.p.A. (Italy)**
  - **SYRMEP beamline – Synchrotron Radiation for Medical Physics:** a high sensitivity X-ray CdTe Detector Single Counting XC-TDI200 from Direct Conversion has been bought and installed, offering a large active area suited for the imaging of large samples at high X-ray energy. First feasibility studies of low dose lung CT on patients and COVID 19 related research have been conducted.
  - **SISSI-BOFF - Synchrotron Infrared Source for Spectroscopy and Imaging – OFFLINE Access**: A nano-imaging module (NIM) for optical near-field imaging (Ps-Het) and Photo-Thermal-Expansion (PTE) resonant imaging with QCL lasers (4 chips) has been ordered and delivered to upgrade the IR s-SNOM "neaSNOM" system (neaspec GmbH) currently available at the SISSI beamline.
  - **TwinMic - Soft X-ray Transmission and Emission Microscope:** no upgrades have been performed so far within the frame of the project. However, in preparation, feasibility studies on ptychography experiments have been conducted to improve spatial resolution. Moreover, a new, wide energy range undulator source has been installed, and new detector systems based on CMOS technologies are currently under evaluation.
  - The **Structural Biology Lab** has acquired the OMNISEC RESOLVE/REVAL system (Malvern) for measurements of absolute molecular weight, molecular size, molecular branching and other parameters. The system was installed in December 2020. It is fundamental for characterizing optimal sample preparation, and is propaedeutic to SAXS and Cryo-EM experiments.
  - **NanoInnovation Lab**.: A new Nikon Eclipse Ti2 Fluorescence Microscopy setup has been ordered, as an upgrade of the facilities available at the NanoInnovation Lab. The new setup will allow quantifying the dynamic functionality of macromolecules within cells with advanced modes asTIRF-FRET (Forster Resonant Energy Transfer) analysis, as well as super resolution optical detection.

- **University of Technology in Graz (Austria) - SAXS Small Angle X-ray Scattering**
  Austrian SAXS beamline at Elettra: A µdrop autosampler has been installed and is routinely in use for studies in structural biology. To complement the offer, a high-end SEC-8 channel MALS system (Agilent/Wyatt) has been ordered.

- The **National Institute of Chemistry in Ljubljana (Slovenia)** - **NMR Nuclear Magnetic Resonance at the Slovenian NMR Centre** has bought a Micro (1 mm) NMR liquid state probe for small sample quantities (5 µl), and ordered an HR-MAS sample changer to be used in combination with the existing HR-MAS probe for semi liquid samples, such as tissues.

2

Training, Industrial Liaison, Communication, Projects

Main Achievements

1 **Educational projects**
Successful implementation of the 5th edition of the training programme for five scientific high schools (PaGES 5).

2 **19 PhD grants co-funded**
of which 14 started in 2020, in collaboration with 10 universities in Europe.

3 **Proposition of IPR Resolution Mechanism for CERIC Framework Agreements**

4 **Organization of events**
to increase awareness of CERIC's offer and services among both scientific and industrial communities.

5 **Transnational cooperation**
in four EU-funded projects.

Training Activities

Education and skills development is a core activity of CERIC. The promotion of training activities was supported in 2020 through the organization of webinars, lectures and workshops, which have continued in a virtual format with the outbreak of the COVID-19 pandemic. A CERIC PhD program also started in 2020, in collaboration with 8 European universities. Some of the implemented actions are presented below.

Training high-school pupils. The PaGES 5 project

PaGES 5 is an educational project targeting 83 pupils from scientific high schools in the Italian region Friuli Venezia Giulia, aimed at acquainting them with the basic tools to plan, manage, execute and evaluate a research project, and to disseminate its results.
Due to the pandemic, the 2019/2020 edition of the project took a hybrid form, starting with lectures and hands-on training in schools, as well as in labs at the CERIC synchrotron facility in Trieste (Italy) until February 2020, then shifting to an online format during the lockdown. The wide programme of theoretical lectures, and the direct experience of a scientific experiment (either in person or virtually) carried out with the support of expert scientists and researchers, empowered pupils to make more conscious choices for their future careers. Lectures focused on project management and business planning, technology transfer and science communication, chemistry and physics, data collection and analysis. Eighty-three pupils took part in the project, as well as ten schoolteachers, six experts in the topic of non-scientific training, and a total of six expert scientists, PhD students and post-doc researchers. At the end of the project, pupils presented the results of the experiments in public online events organized by each school, open to schoolmates, teachers, school managers and local authorities. Outreach activities in the frame of PaGES5 involved nearly five hundred people.

Training PhD students and young researchers

To be sustainable in the long-term, CERIC strives to train young researchers and attract new users to its facilities. To this end, the scientific opportunities available in the Consortium, as well as scientific use cases of the techniques available in CERIC, were presented at scientific events, such as the webinars organized by CERIC's Hungarian Partner Facility, the Budapest Neutron Centre, on the use of neutrons for research on lithium-ion batteries, and on advanced pulsed photon sources, such as Free Electron lasers. More webinars on other scientific topics, such as structural analysis with neutrons, neutron protein crystallography, non-destructive testing with neutrons, and more, were organized within the frame of the ACCELERATE project.
Moreover, in 2020 CERIC launched a call for PhD grants, in collaboration with ten universities in Austria, the Czech Republic, Italy, Romania and Slovenia. From the 19 grants, fourteen selected candidates started their three- to four-year research programmes in November 2020, in fields spanning life sciences and materials sciences, energy materials and heritage science. In the last named, projects aim at investigating the potential impact of state-of-the-art analytical methods, as well as of complementary techniques such as resonant Raman UV spectroscopy and neutron diffraction. Two projects focus on research into batteries, specifically one on the recovery and characterization of layered oxidised materials from spent batteries, and the other on unravelling the electrochemical mechanisms of battery degradation. Finally, seven PhD projects will be carried out within the CERIC internal project INTEGRA, which aim to reinforce, enlarge and better integrate the offer of CERIC Partner Facilities (PFs) in the field of Life Sciences. The five remaining PhD projects will start in 2021.

Human capital development at CERIC and beyond

CERIC has been making continuous efforts towards training and capacity building its staff and managers, adopting a lifelong learning approach. In 2020, due to the pandemic, it became mandatory to develop the staff skills in online communication and videoconferencing platforms, since most of the events and meeting were held online. Another important aspect of the skills development involved open science. The administrative staff also followed dedicated training in matters such as accounting and specific software tools. Also, the staff working on projects assisted training courses for improving their skills in project writing, management and accounting. Throughout 2020, CERIC continued the capacity building activity for industrial liaison and technology transfer (IL/TT) staff of its PFs and other RIs, through open online webinars carried out by international experts, with a focus on IL&TT-related topics. In 2020, eleven webinars were provided to nearly 300 people from PFs and other institutions.

Industrial Liaison Activities

One of CERIC's main strategic goals is to strengthen the whole innovation ecosystem of European stakeholders, both public and private. For this reason, CERIC has also taken a central role in supporting its Representing Entities (REs) in boosting their relationships with industrial stakeholders. In relation to this, an agreement was signed with the Croatian, Slovenian and Polish Representing Entities, or the owners/hosts of the CERIC Partner Facilities (PFs), aimed at fostering industry's involvement and contribute to their technology transfer activities. Collection of innovations coming from these entities has started and is organized in a portfolio, in order to enable their marketing through the CERIC network. The agreement was also presented to the other Representing Entities of CERIC and it is currently under evaluation.

During the year, CERIC continued to enlarge its network through various activities aimed at the business sector. Due to the pandemic, the activities were run online. Specifically, the Industrial Liaison Office (ILO) of CERIC supported the organization of two online Research to Business (R2B) events, each consisting of a series of different webinars. CERIC also kept working on direct commercial activities, and signed an agreement for measurements and data analysis services involving the scientific staff at CERIC in the Pharmaceutical sector, which led to a direct income for CERIC of 15,750 EUR.

In relation to industrial usage of the CERIC Partner Facilities via open access in 2020, 8% of the proposals received were – according to the users – projects with industrial interest. Four percent of total accesses were related to those industrial access requests. In terms of publications, 9% of the articles released in 2020 were related to industry. Such data take into account publications that include authors affiliated to a company, and those that come from industrial proposals.

Under the ACCELERATE project framework, CERIC continued its capacity building activity for PFs related to industrial liaison (IL) and technology transfer (TT), via interactive webinars held throughout the whole year. By implementing an open innovation approach, CERIC invited other institutions to strengthen the innovation ecosystem among European research entities. The five webinars organized focused on a wide set of topics on IL and TT, presented by international experts. Nearly 100 attendees from PFs and other institutions took part in the webinars, which will continue in 2021.

Communication and Dissemination

Communication about CERIC operations and scientific results during the pandemic

Following the outbreak of COVID-19, a great deal of effort has been made in the communication domain in 2020, to inform the scientific community about updates related to transnational open access procedures, which allowed samples to be mailed and experiments carried out remotely. Starting March 2020, the call for fast-track access to the CERIC facilities for COVID-related research has been continuously promoted, also through a video series titled COVID-talks, with interviews with scientists presenting some of the techniques available, also for research on SARS-CoV-2. In addition, CERIC took a leading role in collecting inputs from analytical facilities in Europe on their working practices during the pandemic, in collaboration with the European Research Facilities Association (ERF).
In September 2020, CERIC, as member of the ERF, strongly contributed to participation with a booth at the Science in the City Festival at ESOF 2020 in Trieste, Italy, by setting up a program of live onsite and online talks with scientists from nine of the research infrastructures members of the ERF, to present their research studies to the wider public, in the field of environmental and life sciences, cultural heritage, materials science and astronomy.
Throughout the year, CERIC communication officers also continued to manage the work packages devoted to the communication and dissemination of the results of three European projects: ACCELERATE, PaNOSC and ERIC Forum, within which a number of events, such as project annual meetings, symposia and webinars, were organized and promoted. Newsletters, video interviews, position papers and publications have been continuously released and distributed to the community of CERIC's and its project stakeholders.

Release of a new CERIC corporate video

A new corporate video of CERIC was released in June 2020. The video introduces CERIC-ERIC, the super-laboratory open to scientists all over the world, and gives an overview of the Partner Facilities available to the scientific community. A straightforward explanation of the application process for CERIC open call for proposals is given, and the benefits of CERIC for industry, as well as its active role in the fields of education and science communication are presented.
The video is available at https://bit.ly/CERICvideo

Outreach Events

To increase awareness among the scientific community worldwide about the research opportunities that it offers, CERIC was present at a number of events, including:

Seminars on Physics on Matter at Elettra and FERMI
Trieste - Italy, 28-30 January 2020

International Conference "Environmental Safety of The Carpathian EuroRegion"
Online, 11 May 2020

Webinar by the National Academy of Sciences in Ukraine and the H2020 NCP for Infrastructures in Ukraine
Online, 19 June 2020

Science in the City Festival @ESOF 2020
Trieste - Italy, 2-6 September 2020

ESOF 2020 / Science to Business Programme
Trieste - Italy, 6 September 2020

SOLARIS User Meeting
Online, 9-11 September 2020

BNC webinar series
Online, June-November 2020

Transnational Cooperation

Transnational cooperation is also implemented through CERIC's transnational projects:

Horizon 2020 ACCELERATE project

CERIC coordinates the ACCELERATE project, which aims to support the long-term sustainability of large-scale research infrastructures (RIs) through the development of policies and legal and administrative tools for more effective management and operation of RIs, with a particular focus on ERICs and CERIC.
In 2020, the following deliverables were finalised and submitted:

- **D1.5 Final Impact Assessment Protocol:** The final protocol developed by KNAW-RI, with the collaboration of project partners CERIC, ESS, ELI-DC, HZG, FRM II, describes an approach to anticipating, managing, monitoring and evaluating the societal impacts of research infrastructures.
- **D2.4 Publication policy report:** The report gives an overview of current publication policies adopted by different European RIs, highlighting their different approaches to the same issues, and reflecting on how those could possibly evolve in the near future due to the changing environment and technological capabilities related to open data and similar projects already under implementation, or about to be launched.
- **D3.2 Proposition of IPR Resolution Mechanism for CERIC Framework Agreements.**
- **D4.2 Outpost Event Report:** Report of the outpost events and international scientific conferences organized by the University of Uzhhorod in Ukraine to reach a wider user community. Participants were introduced to CERIC, its PFs and scientific opportunities. Research results in various fields were also presented and discussed, to enable researchers to exchange knowledge and best practices, and to strengthen their scientific network.

2020 publications within the frame of ACCELERATE:

- Kolar, J., Opinion – *Research Infrastructures, Horizon Europe Missions and Wider Policy Goals*, 2020, DOI: https://doi.org/10.5281/zenodo.3888222
- Kolar, J., Harrison, A., Gliksohn, F., *ERF's Review of Working Practices of Analytical Facilities During the Pandemic*, 2020, DOI: https://doi.org/10.5281/zenodo.3813493
- Bozzini, B, Iadecola, A., Stievano, L. *CERIC's report on expert group on batteries*, 2020, DOI: https://doi.org/10.5281/zenodo.3891479
- Kolar, J. *Contribution of Research Infrastructures to the renewed European Research Area*, 2020, DOI: https://doi.org/10.5281/zenodo.3988269

Horizon 2020 E-RIHS PP project

The European Research Infrastructure for Heritage Science (E-RIHS) concluded its Preparatory Phase (PP), coordinated by the Italian National Research Council, and with the participation of CERIC, in September 2020.
During the three years of PP, E-RIHS has established its core documents in preparation for the ERIC. In 2020, these were discussed and validated by the E-RIHS interim General Assembly, composed of representatives of the states that intend to participate in the constitution of E-RIHS ERIC. The E-RIHS interim General Assembly will steer the coordination of members, after the end of the PP, towards E-RIHS ERIC.
For this purpose, in closure of its PP, E-RIHS has delivered an implementation plan to ensure a smooth path after the PP. CERIC-ERIC contributed to the preparation of this strategic document.
With the completion of E-RIHS PP, the formal partnership between E-RIHS and CERIC has come to an end. However, after three years of excellent collaboration, these RIs will maintain close collaboration, also through the Italian ERIC Forum..

Horizon 2020 PaNOSC Photon and Neutron Open Science Cloud

The Photon and Neutron Open Science Cloud (PaNOSC) project is an EU funded project aiming to provide common policies, strategies and solutions for enabling Open Science through the adoption of FAIR principles. In 2020, to make scientific data produced at Europe's major PaN sources fully compatible with the FAIR principles, PaNOSC partners updated and published a new Data Policy Framework addressing FAIR principles, which will be adopted by all partners to ensure they have FAIR data policies in place. To make data Findable and Accessible, a search API has been defined and developed, to enable domain-specific searches across the PaNOSC data repositories. All sites have also implemented the OAI-PMH protocol for indexing metadata and data by OpenAIRE/re3data and B2Find.
The Common Portal for Data Analysis Services has also been under development. Its aim is to provide access to both remote desktop environments and Jupyter Notebooks, enabling users to analyse data remotely from PaN facilities. After initial deployment at facilities to provide remote analysis services to local data, the Portal will be deployed as part of the EOSC to provide federated data analysis of data across the facilities.
Progress has also been made towards the provision of services for simulation and modelling of PaN sources, beamlines and experimental instruments, as well as for start-to-end simulations to describe entire experiments at PaN facilities, which will be provided through the Virtual Neutron and X-Ray Laboratory (ViNYL).
Work on setting up a federated Authorisation and Authentication Infrastructure (AAI), allowing users of PaN facilities to access data and data services seamlessly, has continued in 2020, also thanks to the introduction of the eduTEAMS service operated by GÉANT, in the UmbrellaID infrastructure.
In the field of (FAIR) training, the e-learning platform e-neutrons.org was migrated to ESS, where it is now operating under the domain name pan-learning.org. It will be used to provide training resources for both staff and users of PaN sources. Various solutions for the integration of Jupyter in the platform have been identified, and work has started to integrate federated AAI. Both PaNOSC and its sister project, ExPaNDS, will add new content, and workshops on the features and functionalities of the platform, for both PaN staff and users, have been scheduled in 2021.

Horizon 2020 ERIC Forum project

Aware of the constant enlargement of the ERIC community, the existing ERICs in 2017 formed the ERIC Forum further to strengthen coordination among ERICs. The strategic approach of the ERIC Forum will contribute to addressing critical challenges, develop best practices and frame the necessary knowledge to support ERICs-to-be in various aspects. It will also contribute to building the brand identity of ERICs as an important body and stakeholder in consultation on related policy action.
The ERIC Forum Implementation Project, which was launched in January 2019, has been supporting the achievement of the above-mentioned objectives. Building on the achievements of the first year of the project, ERIC Forum partners, in collaboration with all ERICs, worked on an updated Rules of Procedures (RoP) document towards a permanent and robust governance for the ERIC Forum. The new RoP is publicly available and tackles various angles concerning the election of the ERIC Forum governing bodies.
Moreover, to enhance the importance and diversity of the ERIC community within the European Research Area, and showcase its contribution to societal challenges and to the development of ERIC related policies, in 2020 the ERIC Forum developed and published a set of key position papers/policy briefs: the ERIC Forum Position Paper on Horizon Europe Mission Areas, the ERIC Forum Policy Brief on Funding Models for Access to ERIC Multinational/Transnational Services, the ERIC Forum's response to the public consultation on the future of the ERA, ERIC Forum's contribution to the Open Consultation for the Strategic Research and Innovation Agenda (SRIA) of the European Open Science Cloud (EOSC). Additionally, and to reach a wider audience, the ERIC Forum developed a brochure targeting the general public on the one hand, to introduce the ERIC community, its activities and scope; and other key stakeholders on the other, such as policy makers, and the RI community.

3

CERIC's Institutional Advances and Contribution to Policies

Main Achievements

1. **Collection of information about working practices in the operation of analytical facilities in the time of the pandemic**
2. **CERIC paper on the contribution of Research Infrastructures to the renewed ERA**
3. **CERIC pilot action on batteries**
4. **Contribution to policy papers**
   on ERICs' funding models for access, on Horizon Europe mission area 4: climate-neutral and smart cities, and on the EOSC Strategic Research and Innovation Agenda.
5. **Contribution to the FAIR Research Data Policy Framework for Photon and Neutron facilities**
6. **Membership in the EOSC Association**

COVID-19 related activities

In response to the COVID-19 pandemic, several Research Infrastructures have set up specific services, such as rapid or fast track access, to allow researchers to obtain results as soon as possible. To facilitate their use by researchers, CERIC, in collaboration with the ERF, collected the relevant information about the initiatives through a questionnaire. The input is available in a dedicated page[1] listing more than 50 European RIs' services for COVID-related research, grouped into the following categories: Physical Sciences and Engineering, Health and Food, Digital, Environment, and Cultural and Societal Innovation. In addition to an overview of the services, each category incorporates a summary table with detailed information of the services.

In April 2020, a second questionnaire was sent to European RIs by CERIC, in collaboration with the ERF, to collect information about working practices, and to support the safe operation of analytical facilities during the pandemic. Safety measures of 28 national and pan-European RIs were collected and analysed, up to the publication, in May 2020, of a report[2] including best practices on safety measures that large analytical facilities can adopt during the pandemic.

COVID-19 caused remarkable changes in the operation of European RIs, and perspectives and mind-sets in that regard have been continuously evolving. Another CERIC-ERF report[3] was therefore published in January 2021, following the collection and analysis of the views and experiences of 27 RIs responding to a 3rd questionnaire sent in October 2020. The report highlights the changes and challenges faced by analytical facilities just before the rise of the second wave of the pandemic, which severely interrupted their activities. Despite this, the RIs surveyed have introduced significant changes to their operations, enabling them to return to a situation close to full operation, although with modified access modes. The main changes are related to the increased use of remote access, put in place because of numerous internal developments and improved safety measures.

From the outcomes of the surveys, it can be asserted that COVID-19 gave the opportunity to develop additional services, complementing and reinforcing the already existing ones, making analytical facilities more user-friendly, with remote-access possible to an increased number of instruments (+40% increase over the pre-COVID times) and a wider offer of remote data analysis tools, which will stay available even after the pandemic, e.g., for those scientists who may not be able to travel but who will still have the possibility of conducting experiments from their home country. However, these changes come at a cost of increased needs for staff presence at the instruments, serving remote users, and financial needs for developing remote access solutions.

CERIC paper on the contribution of Research Infrastructures to the renewed European Research Area

In summer 2020, CERIC published a paper[4] on the contribution of Research Infrastructures (RIs) to the renewed European Research Area (ERA), with the aim of examining the potential contributions of RIs to the priorities of the renewed ERA, as proposed by the European Research and Innovation Area Committee (ERAC), and how to carry out the actions proposed to the RIs by the ESFRI WP. It is not a review of the contribution of the versatile landscape of the RIs to the ERA, but primarily addresses the potential of RIs that offer open "physical" access to their facilities for international users.

The main messages of the paper are summarized below:

1. Framework conditions for the production, circulation and use of knowledge, including research career issues

- **Interconnecting ecosystems across EU.** Distributed RIs integrate different national communities and resources at a European level. They are examples of well-functioning partnerships, and their potential contribution to ERA goes well beyond the provision of open access to their facilities. Yet this potential remains poorly visible and largely underexploited. Some good practices of activities that the RIs can strengthen and undertake in a more systematic way are support to joint R&D projects, joint investment in research

[1] https://erf-aisbl.eu/research-infrastructures-offer-for-research-on-covid-19/
[2] Kolar, J., Harrison, A., Gliksohn, F., *ERF's Review of Working Practices of Analytical Facilities During the Pandemic*, 2020, DOI: https://doi.org/10.5281/zenodo.3813493
[3] Kolar, J., Harrison, A., Gliksohn, F., *Effect of the COVID-19 Pandemic on the Working Practices of Analytical Facilities II*, 2021, DOI: https://doi.org/10.5281/zenodo.4431748
[4] Kolar, J., *Contribution of Research Infrastructures to the renewed European Research Area*, 2021, https://doi.org/10.5281/zenodo.3988269

infrastructure, scholarships, training and exchanges of managerial practices. Stressing the importance of these activities in the ERIC Practical Guidelines would contribute to their uptake by future ERICs.

- **Pooling of funds and synergies of funding sources.** RIs should actively contribute to the development of S3 strategies in their member countries and regions, while considering the framework of the new Cohesion Policy. As a matter of urgency, the RIs should also look into the investment priorities of their member countries under the Next Generation EU, and elaborate funding proposals involving the capabilities of the RIs to contribute effectively.
- **Linking research and higher education.** At the onset of the renewed ERA and the Horizon Europe program, RIs might consider strengthening their links with universities even further, including through their association with the relevant European University Networks, thus strategically linking these institutions and contributing to an increased connectivity of the ERA.
- **Contributing to EU's competitiveness.** RIs already contribute to technological innovation, support industrial research and technology transfer and act as intermediaries, including by better directing researchers to funding and/or investment opportunities. Distributed RIs also provide opportunities for knowledge exchange on technology transfer and industrial liaison between the different seats and nodes of the RIs. These activities can be further strengthened by increased integration of the RIs into the innovation ecosystem, be it at regional, national or European level, also by exploiting the opportunities of Horizon Europe, such as Eureka, European Innovation Council, European Institute of Innovation and Technology, as well as other partnerships of Horizon Europe. Furthermore, they can connect to intermediary institutions, such as financial funds and technology parks, and thus contribute to the removal of bottlenecks in the commercialization of inventions and innovations.
- **Increased international cooperation.** Several European RIs are already part of global networks or have established close links with their global counterparts. A good practice for pan-European RIs is to have internationalization strategies, defining the objectives and prioritizing countries and/or regions best suited for their international cooperation. In addition to those of the particular RI, such strategies should optimally also consider the priorities of their stakeholders (e.g. Member Countries) and of the EU.
- **Mobility and human resource development.** In response to an invitation by ESFRI, RIs, together with Members' administrations, should consider setting up clear career paths for staff, aiming at a level playing field for them inside the ERA. They should also engage in the development of actions on mobility and exchange of experience, and in training programmes, including life-long learning, while keeping in mind equal opportunities policies.
- **Open science.** RIs are strongly involved in the development of open science and should continue to contribute to it, including by supporting the newly established European Open Science Cloud Association (EOSC Association) in the delivery of the EOSC. Of particular importance are the preparation of well elaborated business plans, the creation of quality certified FAIR data, and increased attention to the vital need for data professionals for the development of their services. Additionally, they may consider offering data science support and training as a service to users either though open access, or complementary to it.

2. R&I-driven joint action with other policy areas in a global context

- While several of the domain specific ESFRI RIs already address particular challenges, such as those in the domain of health, food or environment, this is often not the case for more general facilities, such as the analytical ones. RIs should respond to the call of ESFRI to focus on EU's strategic agendas by reviewing their current services and optimising their support to specific communities for specific challenges.
- Communication efforts should involve compelling narratives, as well as indicators that would, for example, clearly show to the funders the share of access granted and share of the most cited papers, per SDG, European Green Deal, or other policy objectives. Such a system, which is very much needed, is currently not yet in place.

3. Broad inclusiveness

- While the main objective of RIs is and should remain enabling excellent science, RIs should dedicate more effort to contributing to the ERA objective of inclusiveness, which goes beyond a balanced construction of RIs across the EU. To address the priority better, RIs need to design specific measures to attract members and users from the less R&I intensive regions and develop user communities in these countries. In addition, measures should be put in place to facilitate gender equality and the involvement of minority groups.

The paper finally invites the EC to consider updating the European Charter for Access to Research Infrastructures, and ESFRI to consider including RIs' contribution to inclusiveness in their monitoring and evaluation system.

CERIC's contribution to battery research

Following the CERIC General Assembly decision, in June 2019, to focus increasingly on and elaborate further the fields of energy materials and life sciences, in May 2020 an external scientific advisory group of appointed distinguished experts (Antonella Iadecola, Lorenzo Stievano and Benedetto Bozzini) submitted for discussion at the meeting of the ISTAC of CERIC, a report on batteries[5], which identifies the bottlenecks and needs for upgrades of the CERIC infrastructure in this domain, towards the production of the CERIC Research and Infrastructure Roadmap.
The ISTAC found the report excellent and valuable, and proposed the preparation of an action plan based on the recommendations proposed in the document, including a feasibility assessment of the improvements suggested for the existing facilities, and of the new techniques and facilities proposed.
The report of the advisory group starts with an introduction on the importance and relevance of battery research, mainly due to the increasing energy demand associated with population growth and industrial development, and to the current greatest challenges given by climate change, which are clearly indicating that a paradigm shift from fossil fuels as the primary power supply towards greener and more sustainable resources is mandatory. Research has therefore been looking for safer and more powerful rechargeable batteries. In this respect, thanks to their rechargeable power, high-energy secondary batteries represent the most promising strategy for an oil-free future, within which lithium-ion batteries (LIB) take an important position.
Improvement in the performance of LIB, as well as an improved understanding of post-LIB systems resides in the availability of cutting-edge techniques, requiring innovative cell design for both *ex situ* and *in situ / operando* study of both the structure and reactivity of battery components, and especially of the interfaces. The development of new space-resolved characterisation tools (and improvement of existing ones, especially in the time scale), and often the coupling of several of them, are essential to better understand them, and thus to improve their performance.
The instruments and techniques available in CERIC for battery research are highlighted in the report, with a description of their possible use for battery studies, and suggestions for a possible adaption to increase research in this field. In addition, the techniques, support laboratories and calculation facilities, which would still need to be included in the CERIC offer for the study of batteries, are listed and described.
The establishment of a Technical Battery Advisory Board (TBAB) is recommended to foster multi-technique access to CERIC facilities by new members of the battery community. The TBAB could offer support to both users who are not expert in the methods offered, and to beamline/instrument scientists who are not electrochemists. On the users' side, the TBAB could support battery groups needing advice on the kind of information provided by the available methods, and help them interact with beamline/instrument scientists, for the preparation of proposals and experiments.
A set of recommended communication and funding actions follows. With reference to the latter, the expert group encourages the continuation of the already activated CERIC scheme of funding PhD scholarships for battery work across CERIC facilities. These may be supplemented with post-doc scholarships, which would further consolidate cross-technique activities. It is also suggests funding instrument-oriented activities aimed at battery work, favouring *in-situ* work, and proposes an internal competitive scheme for CERIC facilities to access this type of funding.
The authors of the report concluded that the suite of CERIC's instruments already offers an outstanding opportunity for state-of-the-art and next-generation battery research. Moreover, the cornerstone of CERIC, i.e., fostering complementary multi-technique studies, is especially crucial to electrochemical energetics, battery science and technology. The balanced mix of available techniques, integrated along the lines presented in the report, can thus fit to the framework of EU initiatives to foster battery studies through synergies among European analytical facilities, computing centres and industry. By strengthening battery activities, CERIC will be in a position to contribute to the BATTERY 2030+ roadmap and related common efforts to develop a strong European route to next-generation batteries.
In synergy with the successful pilot on batteries, ISTAC also recommended a follow up with a pilot on fuel cells.

[5]Report of CERIC's Expert Group on Batteries, B. Bozzini, A. Iadecola A., L. Stievano, June 2020, DOI: https://doi.org/10.5281/zenodo.3891442

Funding models for access to ERIC multinational/transnational services: key recommendations

In September 2020, the ERIC Forum, with the contribution of CERIC and ERICs partners in the project, published a policy brief[6] presenting an overview of the current situation and an in-depth analysis of the funding instruments that allow ERICs to provide access to their high-quality services, and to support multinational ground-breaking research. The brief showcases ERICs' experience and provides outlooks for the use of national funding schemes, ERA-Net and European Joint Programme (EJP) mechanisms, regional funds for cross-border projects, the European Research Council (ERC) funding scheme, Horizon 2020 and Public-Private Partnerships (with a special focus on Horizon Europe), the Transnational Access schemes and the funding mechanisms for short-term mobility and fellowships, thus providing insights for the optimal use of existing funding instruments, and for the advancement of the visibility of ERICs and other RIs among research communities.

The following key recommendations, as highlighted in the policy brief, and which reflect the outcomes of the exchanges of the Forum with funding bodies and other key stakeholders, aim to stimulate a stronger dialogue and more efficient synergies between funding sources:

- ERICs should be fully eligible and be recognized by national funding agencies, and cross-border funding from national funding agencies should be promoted;
- ERICs and funding bodies at all levels can join efforts to improve ERICs' visibility and attractiveness. Funding bodies should actively refer applicants to ERICs, encouraging and providing incentives for their use;
- Transnational Access mechanisms must be safeguarded, and expanded to support ERIC consolidation, respond to specific challenges, develop research communities and provide a flexible budget for sustainable access for competitive projects;
- Simplification of the application and financial processes for distributed RIs in Horizon funding can help to overcome bureaucratic hurdles and boost the visibility of ERICs;
- Dialogue and collaboration among national, regional and European funding bodies must be strengthened to ensure the alignment of strategies and the synergic use of resources.

In the conclusions, the policy brief explicitly states that, given the diversity of ERICs, funding mechanisms should be carefully adapted to the long-term operational needs of each individual ERIC. For further exploration of open questions and to continue reflecting on pragmatic solutions (e.g., the creation of a centralised budget, strategies further to develop services for private stakeholders, co-funding mechanisms, co-creation and co-design of research projects between ERICs, etc.), a dedicated working group has been created to enable the ERIC Forum to continue playing an active role in improving the visibility of ERICs and in maintaining an open and sustainable dialogue with the European Commission, ESFRI and national public funding bodies.

The ERIC Community and Horizon Europe mission areas

In June 2020, the ERIC Forum published a paper[7] describing how the Forum, together with four preparatory ERICs, contribute to the mission areas developed for the next European Union's Research and Innovation Framework Programme, Horizon Europe. CERIC provided inputs for mission area 4: climate-neutral and smart cities, which aims to contribute to the goal of achieving Europe's carbon neutrality by 2050, as envisaged by the European Green Deal, and to

[6]https://www.eric-forum.eu/wp-content/uploads/2020/09/ERIC-Forum_Policy-Brief.pdf
[7]ERIC Forum, *The ERIC Community and Horizon Europe mission areas*, September 2020, https://www.eric-forum.eu/2020/06/12/the-eric-community-and-horizon-europe-mission-areas/

which ERICs can jointly offer valuable support towards its delivery.
In this respect, and as stated in the paper, "ERICs will contribute to the development of technologies in support of the transition towards carbon neutrality, particularly in the fields of green energy and energy storage, but also carbon capture and utilisation (e.g., conversion), energy efficient materials and similar. By offering techniques based on photons, neutrons, ion beams, electrons and NMR, they are particularly well-suited to support the development of these technologies. Their achievements in the field range from use and storage (CCUS) technologies, green technologies implemented in the energy and industry sector to reduce and neutralise CO^2 emissions in and close to cities, improvement of mobility with better batteries, longer lasting solar cells, and more efficient wind turbines and power grids, to name a few. The contribution of these facilities to the objective of carbon neutral cities will also entail reduction of their own carbon footprint".

EOSC Strategic Research and Innovation Agenda

CERIC, as a partner of the PaNOSC and ERIC Forum H2020 projects, contributed to the Strategic Research and Innovation Agenda (SRIA) for EOSC , a roadmap for realising EOSC, built on the outputs of the EOSC Executive Board Working Groups presented at the EOSC Symposium 2020 in October 2020, as well as on the feedback received from the community via the Open Consultation on the EOSC SRIA over the summer. SRIA will support the European Commission in developing the next work programme Horizon Europe (2021-2027), since the EOSC is an integral part of the European Commission's strategy for realising and revitalising the European Research Area (ERA).
To contribute to the SRIA, CERIC, together with the partners of the PaNOSC H2020 project, and in collaboration with European e-infrastructures and the other four ESFRI science cluster projects (ENVRI, SSHOC, ESCAPE and EOSClife) provided a set of recommendations and points for further consideration and reflection, to integrate them in the EOSC roadmap, and which are reported below:

- **Research-oriented services:** In an EOSC, which is envisioned to be an inclusive and federated ecosystem based on FAIR data and other open science outputs, integrating many services such as data visualisation, analysis and physical resources to store and re-use data for open science, EOSC is expected to take up the mandate of providing the resources required for the re-use of data.
- **Trust based open access:** Using EOSC services must be easy, with low barriers and transparent access mechanisms. Similarly, contributions to EOSC should not be subjected to overly complex regulation. A careful balance between a top-down and bottom-up approach in the design and governance needs to be built on trust to allow a user friendly EOSC.
- **Collaboration support:** The EOSC user communities, service providers and governance must work closely together to ensure that EOSC is capable of adapting to innovative emerging needs. This implies a stronger coordination of on-going and future EU funded projects and the strong participation of the user communities in the EOSC governance.
- **Sustainability:** The EOSC must have sustainable funding from the relevant authorities, particularly the Member States, allowing long-term service provisioning, data preservation, and concrete support. Simple funding mechanisms that avoid complex commercial transactions have to be found. Sustainability is fundamental for the long-term engagement of all key actors, and notably in attracting a large scientific user community.

The ERIC Forum - whose partners are widely involved in the abovementioned EOSC projects - also responded to the Open Consultation on the EOSC SRIA. In addition to committing to making data, publications and software as open and accessible as possible, adhering to FAIR principles, the Forum also suggested the development of a robust policy on data verification and software and service assessment. As stated by the Forum, given that several research domains face structural difficulties related to delivering FAIR data, research communities need support, new skills and appropriate tools and services related to each phase of the data management process. The ERIC Forum therefore advocates for a vigorous data policy framework and looks forward to working closely with EOSC on making such policy.

FAIR Research Data Policy Framework

CERIC, within the frame of the PaNOSC H2020 project, contributed to the update of the PaN-Data policy released ten years ago within the PaNdata FP7 project. The new FAIR Data Policy framework for research data describes a common framework for management of scientific data at photon and neutron facilities, and will be used by CERIC and the photon and neutron facilities in the PaNOSC and ExPaNDS' communities, to ensure research data is FAIR. The goal is to support data stewardship at PaN facilities, by defining the curation of data and metadata, from the generation of raw data from each experiment, to analysis of the data and further re-use.
The report outlines how to interpret the **FAIR principles**, a set of guiding principles to make data Findable, Accessible, Interoperable and Reusable, giving indications on the rights and obligations of both research infrastructures and researchers, in terms of acquisition, storage, preservation and sharing of data generated at the facility and its associated metadata.

Having an open access data policy with data in well-defined formats has many benefits:

- It makes previously measured data available for further analysis without the need to repeat the experiment.
- It promotes data use, cross-disciplinary research and machine learning.
- Raw data becomes open to scrutiny by other researchers, which ensures scientific integrity and the reproducibility of experiments.
- Scientists can mine data in previously unknown ways or reapply new methods to existing data.

The **data format** is an essential part of making data inter-operable and machine-readable. Thus, for raw data, a common data format, i.e., NeXUS/HDF5, is recommended, which, in addition to the detector data, includes sample, instrument and scientific metadata. This ensures higher compatibility and reusability of data, as well as of all the analysis tools developed by any of these RIs.
The data policy also recommends users to ensure that raw and processed data are collected with accurate **metadata** to fulfil the FAIR principles, and that access to raw data, facility processed data, auxiliary data, results, and the associated metadata is restricted to the experimental team during the embargo period (i.e., the maximum period during which the data generated by experiments performed will remain private), after which data and metadata have to be made publicly accessible.
The full strength of this digital approach will be achieved when all data, from the detector to the final publication, are included in a digital object that is machine readable, giving full advantage to the experimental team and the scientific community. Facilities should therefore generate **DOIs** for one or more specific datasets, to be cited in a publication, which would allow reusability of the same datasets by other research teams from the same or from different domains.
The PanOSC Data Policy framework was evaluated according to the FAIR Data Maturity Model, which led to further improvements of the data policy.

Contribution to ERIHS' methodology for accounting in-kind contributions

The European Research Infrastructure for Heritage Science Preparatory Phase project started in January 2017, coordinated by the Italian National Research Council. The ambition of E-RIHS, as an interdisciplinary infrastructure delivering innovation, is to provide tools and services for cross-disciplinary research aimed at advancing the understanding and improvement of protection and broadening access to the European heritage, through a platform of cooperation for national academies, research centres and cultural institutions.
E-RIHS is envisioned to become a distributed RI, led by Italy, based on two different level of commitments expected from member states: cash contributions towards the operation of the central hub and in-kind contribution towards the operations of national nodes.
In January 2020, a methodology for accounting the in-kind contributions, to which CERIC made its contribution, was accepted by the partners on the occasion of the annual project meeting held in Evora (Portugal). In February 2020, a specific project deliverable (D3.4) was positively reviewed by the competent offices of the European Commission.

The suggested approach was based on:

- The mission of E-RIHS; its mission is to deliver integrated access to expertise, data and technologies through a standardized approach, based on different services organized in four platforms.
- The structure of E-RISH ERIC, as a distributed research infrastructure.

The goal of E-RIHS is to grow and strengthen a creative, European-wide framework for supporting frontier research in heritage science. It will do so by offering access to expertise, data and technologies through a standardized approach based on services organized in four platforms.
In June 2020, the European Strategy Forum on Research Infrastructures (ESFRI) carried out monitoring of the research infrastructures listed as Projects dating from 2016, as described in the ESFRI Strategy Document and Roadmap 2018, approving the European Research Infrastructure for Heritage Science Preparatory Phase project.

Workshop on Impact Assessment, Evaluation and Monitoring of RIs

CERIC, together with the Rathenau Institute, European Spallation Source, and EFIS Centre, respectively representing the 3 co-organizing H2020 projects ACCELERATE, ERIC Forum and RI-PATHS, organized an online workshop highlighting recent developments in the field of impact assessment, scientific evaluation and monitoring of Research Infrastructure. The event brought together more than 130 participants from over 65 different organizations, representing Research Infrastructures' (RI) communities, policy makers, funding agencies and more, to tackle the topic from different perspectives. The event focused on 3 main areas: 1) scientific evaluation, 2) monitoring and 3) socio-economic impact of research infrastructures.
To showcase the full picture of a scientific evaluation example, the ERIEC (European Research Infrastructure Evaluation Consortium) scientific evaluation methodology was presented through the ECRIN-ERIC experience, highlighting its process, timeline, efforts, results and usefulness.
Moreover, the event provided an overview of the ERIC Forum's survey and position paper on the development of Key Performance Indicators (KPIs) for RIs, grouping input from 32 European Research Infrastructures about their KPIs' status and motivation, as well as feedback on ESFRI KPIs. It was also an opportunity to get policy makers' updates on the topic, specifically referring to the ESFRI RI monitoring approach. These were important aspects to tackle considering that over 75% of the attendees monitor their performance with KPIs as a useful tool for monitoring, although nearly 70% of them have difficulties in defining KPIs.
The session focusing on socio-economic impact provided an overview of the societal impact protocol approach developed by the Rathenau Institute within the frame of the ACCELERATE project. The approach was a tool for project partners (CERIC, European Spallation Source, ELI, HZG and FRMII) to apply the methodology for their respective RIs/ERICs and therefore develop their social return report. During the workshop, each partner presented the results of this exercise and the main impact pathways and areas of their infrastructures identified throughout the assessment process.
In addition to the results, the presentation of the ACCELERATE and RI-PATHS' case studies also included an overview of the purpose of the assessment, the approach followed by the RI and the efforts in terms of person month needed for the completion of the societal report. The aim was to highlight to the audience the application of the protocols by RIs from different sectors, structures and objectives, showcasing the key learning points from the study of the impact and its added value.
For the event's attendees, over 80% of them define the main value of impact assessment in terms of conveying the RI's impact to its stakeholders (such as its funders), and over 65% in its usefulness as a strategic tool to steer activities towards enhanced impact.

Membership in the EOSC Association

In October 2020, CERIC was accepted as a provisional member of the EOSC Association, immediately after the Association was constituted. In December, during the first Constitutional GA, the delegates of the four founding members admitted 138 provisional members (including CERIC) and 49 provisional observers. CERIC confirms in this way its commitment to implementing open science and open data and to contributing to the development and success of the EOSC.

4

Operations and Finance

Main Achievements

1. **Adoption of the new CERIC Data Policy**
2. **Fruitful discussions towards a new CERIC's business model**
3. **IKCs, VAT and Excise Exemptions**
   Progress and updates.
4. **Financial and in-kind annual account**
   for 2020 and estimate of the auditable values to be included in the Annual CERIC Account.

Adoption of the new CERIC Data Policy

In November 2020, the General Assembly of CERIC-ERIC approved the new CERIC Scientific Data Policy, which applies to all CERIC instruments and Partner Facilities (PFs), in harmony with FAIR principles, the PaNOSC and ExPANDS data policy frameworks and the National Data Policy of each country, if existing.
The Policy describes scientific data management at CERIC PFs, with the purpose of defining the time, manner and place in which data, metadata and raw data are or will be stored. The process includes the generation of raw data (whenever feasible and practical, using the standard NEXUS/HDF5 format) from each experiment, which is then analysed by the research team.
Given that CERIC has committed to providing FAIR data by the end of 2022, the data policy sets the principles for managing data while the CERIC infrastructure for data management is being developed.
The Scientific Data Policy is accepted by users during the submission of their proposals.

Towards a new business model - Potential introduction of fees

In June 2019, the General Assembly of CERIC initiated a discussion on how to modify the business model of the Consortium. Up to now, it has been based solely on in-kind contributions by the Members (in the form of the operation of the Partner Facilities), complemented by the sole financial contribution by the Member hosting the Statutory Seat. A more sustainable model was proposed by the Executive Director, based on monetary contributions by all Members, 90% of which is to be devoted to the enhanced integration of the Partner Facilities.

The proposal was based on the following elements:

- The Host premium of the country hosting the seat is maintained at 5,5 MEUR, to be used for strengthening the CERIC integrated operations, including training, technology transfer and communication.
- The overall additional monetary contribution is set at ca. 1 MEUR. This is roughly 10% of the annual cost of the operation of CERIC, including the Partner Facilities.
- Fixed contribution, the same for all.
- Variable contributions by the Member States based on their percentage of total GDP of all EU Member States.
- The annual contribution by each member should be devoted mainly to improving and integrating its facilities.

After a constructive discussion on the proposed model, the General Assembly of CERIC agreed that the delegates review the proposal within their Ministries, also to discuss and provide feedback on the draft Consensus Agreement on Financial Contributions, presented to the General Assembly meeting in November 2020.

IKCs, VAT and Excise Exemptions

The full implementation of the ERICs depends mainly on the proper use of fiscal exemptions granted to international organizations, as well as to the implementation of simplified procedures agreed with national fiscal authorities. The relevance of this topic at European level is described in a report from the Commission to the European Parliament and the Council on the Application of Council Regulation (EC) No 723/2009 dated 14.07.2014, within a chapter devoted to “pending issues and next steps”. In this document, it was clearly stated that “There are also questions to clarify as concerns in-kind contributions to an ERIC by its members, in particular as to whether these contributions could benefit from the VAT and excise duty exemption and, if so, under what conditions”.

During 2020, the VAT and excise exemptions issues, as well as the implementation of a methodology for managing the IKCs provided by the Member States to the ERICs, have been analysed within the ACCELERATE project, which aims to support CERIC sustainability through activities of collaborative development of policies with other research infrastructures (RIs), in particular new and forming ERIC entities.
Within this initiative, two specific deliverables planned at the beginning of 2021 have been drafted in collaboration with the project partners, and in particular ESS (WP1 led by CERIC ERIC - D1.6 - VAT/excise duty exemption progress report; D1.8 Comprehensive methodology for IKC accounting).

The conclusions of the final version of the documents also take into consideration the main outcomes of the discussions developed within the ERIC Forum project, and in particular its work package 3 – Operations, Administration, HR and Finance of ERICs.
In the second half of 2020, some initiatives have been undertaken to simplify the VAT exemption procedures referring to the intra Community acquisition of goods and services, addressing a specific consultation to the Italian tax and economic authorities.

In particular the consultation was intended to ask for the exemption from the certificate laid down in Annex II of the Reg. 282/2011/EU, within the meaning of Art. 51 paragraph 2, according to which “(...) However, if the goods or services are intended for official use, Member States may dispense the recipient from the requirement to have the certificate stamped under such conditions as they may lay down.”

The exemption from the above-mentioned certificate has been requested with reference to purchases made directly by Italian ERICs for their exclusive use, as well as within their institutional activity of a scientific character.
Moving to the IKCs issues, the activities carried out within the project ACCELEREATE have focused on defining the limits and the subjective/objective conditions for the Members to benefit from VAT/duty exemptions for in-kind contributions provided to the ERICs through their Representing Entities, outlined by effective cases developed in some countries, also by making reference to the current position of the Commission Tax Services with reference to these operations.

Financial Statements 2020

Balance Sheet - Assets and Liabilities	2020	2019
ASSETS	**7,354,431.45**	**5,643,665.73**
Non-current Assets	**961,803.73**	**476,127.80**
Plant, property and equipment	923,575.62	436,383.87
Intangible assets	38,228.11	39,743.93
Investments in associates	-	-
Current Assets	**6,392,627.72**	**5,167,537.93**
Inventories	47,826.09	-
Long-term credits	-	-
Short-term credits	64,198.94	62,259.01
Other current credits and receivables	-	-
Cash and cash equivalents	5,823,139.02	5,097,254.56
Prepayments and accrued income	457,463.67	8,024.36
EQUITY AND LIABILITIES	**7,354,431.45**	**5,643,665.73**
Equity	**-**	**-**
Equity	-	-
Capital and other permanent contributions from Members	-	-
Reserves	-	-
Accumulated profits	-	-
Non-current Liabilities	**1,070,855.93**	**1,064,965.49**
Long-term financial debts and loans	-	-
Other long-term debts and liabilities	-	-
Advance payments for externally funded projects	923,644.46	943,360.77
Pensions funds and other benefits for compensation employment	147,211.47	121,604.72
Long-term provisions	-	-
Current Liabilities	**6,283,575,52**	**4,578,700.24**
Short-term financial debts	-	-
Other short-term debts and liabilities	547,447.58	276,557.95
Advance payments for externally funded projects	-	-
Other current payables	301,315.42	212,674.92
Contingent liabilities	40,783.62	40,783.62
Deferred income and accrued expenses	5,394,028.90	4,048,683.75

Profit and loss account		2020	2019
Revenues		**2,167,630.01**	**2,356,538.06**
	National and international grants and contributions	2,167,475.62	2,088,421.30
	Contributions in-kind	-	236,454.00
Other revenues	Other revenues	154.39	4,662.76
Operating costs		**2,007,880.15**	**2,259,490.55**
	Costs for raw materials, supplies and goods	47,677.44	45,792.33
	Costs for services	505,978.82	542,765.90
	Resources committed in-kind to CERIC from contributors	-	263,454.00
	Staff costs	1,441,178.17	1,403,650.71
	Costs of rents, concessions and royalties for trademarks	-	-
Other operating costs	Costs for institutional activities	3,200.32	3,827.61
Ebitda (Earnings before Interest, Taxes, Depreciations and Amortizations)		**169,595.26**	**97,047.51**
Depreciation		137,883.03	68,125.90
Write-downs for impairment of tangible and intangible assets		-	-
Ebit (Earnings before interest and taxes)		**31,712.23**	**28,921.61**
Financial income and expenses		**-314.23**	**-655,61**
	Financial income	413.21	401.50
	Financial charges	-727.44	-1,057.11
Income from investments		-	-
Value adjustments to financial assets		-	-
Result before tax		31,398.00	28,266.00
Taxes		31,398.00	28,266.00
Result for the year		**-**	**-**

Notes to the Financial Statements as at December 31, 2020

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. For this purpose, it is relevant to recall the “Report from the Commission to the Council and the European Parliament towards implementing harmonised public sector accounting standards in Member States. The suitability of IPSAS for the Member States”, published in March 2013.
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 nations;
- 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.

It has 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 analysing 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 realized during the normal operating cycle of the institution;
- They are cash or equivalent complement not restricted in its use.

Assets realizable within the operating cycle have been classified as current, regardless of whether they have actually been realized 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 realizable 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 recognized as non-current liabilities.

Deferred Incomes and Accrual Expenses

This item includes the amount of funds received up to December 2020 and not yet fully used by 31.12.2020 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 2020.

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", under the conditions specified therein and only as a result of auditing carried out by local auditors, which will be comparable with that of CERIC auditors.

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.

In-kind Contributions

In-kind non-monetary contributions will be distinguished (when realized) 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).

Assets

Non-current Assets

Tangible Assets

Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
436,383.87	923,575.62	487,191.75

86% of the represented increase refers to purchases linked to the running of internal research projects; 14% refers to supplies for the central seat.

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

Description	Property	Technical furniture	Electronic office machines	Office furniture	Mobile phone	Equipment in progress	Total
Balance as at 31/12/2019	**-**	**211,380.02**	**29,815.21**	**18,902.78**	**1,879.25**	**174,406.61**	**436,383.87**
Acquisitions during the year	-	520,745.75	3,978.50	7,063.00	139.99	417,983.86	949,911.10
Increases during the year	-	-	-	-	-	-	-
Decreases during the year	-	-	-	-	-	-338,980.66	-338,980.66
Depreciation for the year	-	-109,436.53	-8,881.67	-4,776.05	-644.44	-	-123,738.69
Balance as at 31/12/2020	**-**	**622,689.24**	**24,912.04**	**21,189.73**	**1,374.80**	**253,409.81**	**923,575.62**

The balance sheet items “Decreases during the year” refers to the completion, in 2020, of the supply of scientific instruments; its value is included under the acquisition made during the year.

Intangible Assets

Balance as at 31/12/2019	Balance as at 31/12/2020	Difference
39,743.93	38,228.11	-1,515.82

Historical costs at 31/12/2020 are as follows:

Description	Balance as at 31/12/2019	Operating increments	Operating decreases	Depreciation for the year	Value on 31/12/2020
Concessions, licenses, trademarks	39,743.93	12,628.52	-	-14,144.34	38,228.11
Intangible assets in progress	-	-	-	-	-
Total	**39,743.93**	**12,628.52**	**-**	**-14,144.34**	**38,228.11**

Most of the increments refer to intangible assets related to the realization of the CERIC corporate video.

Current Assets

Short-term Credits

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

Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
62,259.01	64,198.94	1,939.93

The composition of the amount as at 31/12/2020 is as follows:

Description	Within 12 months	Over 12 months	Over 5 years	Total
Advances to suppliers	488.68	-	-	488.68
Other receivables	226.07	-	-	226.07
Tax advances	28,314.00	-	-	28,314.00
Credit notes to be received	505.39	-	-	505.79
Receivables from EU projects	31,694.80	-	-	31,694.80
Receivables from customers	-	-	-	-
VAT credit	2,970.00	-	-	2,970.00
Total	**64,198.94**	**-**	**-**	**64,198.94**

- The balance sheet item "Advances to suppliers" represents the part of the expenses paid to suppliers for activities that will be implemented at the beginning of 2021.
- The balance sheet item “Other receivables” mainly refers to reimbursement to be received in relation to travel bookings cancelled.
- The balance sheet item “Tax advances” refers to advance payments made in June and November 2020. These advance payments have been calculated on the basis of the fiscal charge for the previous year.
- The balance sheet item “Receivables from EU projects” refers in particular to a surplus between the costs claimed within the project E-RIHS and advance payments received by the European Commission.
- The balance sheet item “Receivables from customers” refers to limited commercial activities started in the last quarter of 2019.
- The balance sheet item “VAT credit” refers to fiscal credit accrued as at 31.12.2020 for purchases from Italian suppliers in order to carry out limited commercial activities.

Inventories

Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
-	47,826.09	47,826.09

The balance sheet item "Inventories" represents the evaluation as at 31.12.2020 of a commercial contract signed with the Italian representing entity, with a duration of over a year.

Cash and Cash Equivalents

The balance represents cash at the bank at the end of the financial year. It represents liquid assets and cash equivalents at the end of the year.

Cash deposited at the bank Unicredit Banca Spa:

Description	Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
Bank deposits	5,097,254.56	5,823,139.02	725,884.46

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 December 2020, a sum of € 2,804,535.00 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, according to the Collaboration Framework Agreement signed with Elettra-Sincrotrone Trieste S.c.p.A. In June 2020, CERIC received from the EU an amount of € 260,503.98, as interim payment for the ACCELERATE project. In October 2020, CERIC received from the EU an amount of € 465,987.50 as first advance payment for the PaNOSC project. In December 2020, CERIC received an interim payment for the ERIC Forum project, in the amount of € 65,161.64. In the ACCELERATE project, CERIC acts as project coordinator. In the other two projects, the Consortium acts as project partner.

Prepayments and Accrued Income

Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
8,024.36	457,463.57	449,439.31

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 (€ 438,413.64) represents prepaid expenses related to costs for three-years PHDs program referring, on an accrual basis, to the period 2021- 2024. The remaining part (€ 19,050.03 refers to prepaid expenses related to the general costs of the Consortium) The objective of this activity is to further the integration of the partner facilities and to contribute to excellent science.

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

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	E-RIHS	ACCELERATE	PaNOSC	ERIC Forum	Total
Balance as at 31/12/2019	-	298,578.87	599,444.39	45,337.51	943,360.77
Advance payment received from the EU during the year	-	260,503.98	465,987.05	65,161.64	791,652.67
Transfer of funds to project partners	-	-135,116.66	135,116.66	-	135,116.66
Accrual progress report for the period Jan-Dec 2020	-15,260.88	-222,079.58	-414,302.79	-47,635,95	-699,279.20
Amount exceeding the advance payment received	15,260.88	-	-	-	15,260.88
Depreciation costs related to investments made in 2019			4,946.00	2,820.00	7.766,00
Balance as at 31/12/2020	**0,00**	**201,886.61**	**656,074.65**	**65,683.20**	**923,644.46**

The item "Advance payments for externally funded projects" includes:

- The second advance payments related to the ERIC Forum project (€ 65,161.64) funded by the EU. The project has a duration of 48 months and will finish in December 2023. CERIC acts as project partner.
- The interim payment referring to the PaNOSC project (€ 465,987.05) funded by the EU.
- The interim payment referring to the ACCELERATE project (€ 260,503.98) funded by the EU. The project has a duration of 54 months and will finish in June 2021. CERIC acts as project coordinator.

The advance payments received relate to the implementation of the activities described in the project, and it must be returned only if CERIC does not carry out the project, or if it does not comply with the contractual obligations towards the EU.
The final amount at 31/12/2020 has been calculated on the basis of the progress reports of the projects ACCELERATE, E-RIHS, PaNOSC and ERIC Forum, with reference to the incurred costs for the period January - December 2020 (€ 691,513.20).

In view of the fact that an adequate evaluation cannot be made of the advances referring to the activities that will be carried out in the next 12 months, there is no possibility of splitting the total amount between non-current and current parts.

Description	Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
Advances	943,360.77	923,644.46	-19,716.31

Pensions Fund and Other Benefits for Compensation Employment

Severance indemnities for employees.

Description	Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
Severance indemnities for employees	121,604.72	147,211.47	25,606.75

The item is made up as follows:

Description	Initial value 31/12/2019	Plan balance 2020	Substitutive tax	Contribution to national funds for employees (FPLD)	Severances paid during the year	End value 31/12/2019
Severance indemnities for employees	121,604.72	52,845.95	-264.94	-3,706.68	-23,267.58	147,211.47

The severance set aside figure represents the actual debt of the Consortium at 31/12/2020, to 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 to the expiration of two fixed-term contracts during 2020.
As at 31/12/2020, advances have not been required by employees.

Current Liabilities

Other Short-term Debts and Liabilities

Debts

The composition of the aforementioned amounts is as follows:

Description	31/12/2019	31/12/2020	Variation
Debts to providers	130,083.13	382,023.30	251,940.17
Tax liabilities	94,944.77	119,673.90	24,729.13
Payables to social security institutions	51,530.05	45,750.38	-
Total	**276,557.95**	**547,447.58**	**270,889.63**

“Debts to providers” are stated net of possible trade discounts.

Balance at 31/12/2019	Balance at 31/12/2020	Variation
276,557.95	547,447.58	270,889.63

Debts are valued at their nominal value.

The item “Debts to providers” (€ 380,023.30) 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 € 47,103.25, together with € 41,172.65 of VAT to be paid in 2020, and taxes due by the Consortium (€ 31,398.00). With reference to this last item, an advance payment was made in 2020 to a total amount of € 28,314.00.

“Payables due to social security institutions" includes the amount of social security contributions relating to employees, accrued but not paid as at 31 December 2020, amounting to € 45,750.38.

"Other payables" 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 31/12/2020 was as follows:

Description	31/12/2020
Payables to employees (holidays and leave not taken)	75,029.07
Other payables to employees	21,988.64
Payables to bodies	4,166.67
Other debts of a different nature	160,131.04
Advances from customers	40,000.00
Total	**301,315.42**

The item “Payables to bodies” relates to the fee due by the Consortium to an internal auditor.

Debts are evaluated at their nominal value.

Description	31/12/2019	31/12/2020	Variation
Other payables	212,674.92	301,315.42	88,667.50

The final value as at 31.12.2020 refers mainly to the additional administrative and general services activities provided by Elettra for the statutory seat in 2019 (€ 111,274.54) and 2020 (€ 46,803.52). In particular, these additional activities refer to:

- The development of specific software packages needed to implement the annual programme of CERIC-ERIC and to increase the efficiency of the administration of users, as well as other administrative processes of CERIC (Implementation of the Virtual Unified Office – VUO)
- The involvement of Elettra's operational structure and personnel for other CERIC institutional activities (General Assembly secretariat, legal advice, preparation of collaboration agreements, logistic services, spaces and related utilities, travel costs for scientific users).

Contingent liabilities

Description	Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
Contingent liabilities	40,783.62	40,783.62	-

The final value as at 31.12.2020 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 31/12/2019	Balance as at 31/12/2020	Variation
4,048,683.75	5,394,028.90	1,345,345.15

The item breaks down as follows:

Description	Amount
Deferred income	5,394,028.90
Accrued expenses	0,00

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.

The amount of € 5,384,183.50 is derived as follows:

Category	Carry over 2019	Italian Contribution for 2020	Consortium general expenses for 2020 covered by FOE	Consortium general expenses for 2020 covered by FOE 2018/2019	Depreciation quotes to be covered by external projects	Deferred incomes as at 31.12.2020
Deferred income	4,048,683.75	2.757.731,48	-1.158.928,65	-245.691,68	-7.766,00	5,394,028.90

The Italian contribution for 2020 (€ 2,804,535.00) initially defined in the collaboration framework

agreement signed by CERIC and its Italian Representing Entity for the period 2017-2019, was recalculated taking into account the additional activities performed by Elettra-Sincrotrone Trieste S.c.p.A. (€ 46,803.52) for spaces rented to CERIC.

The amount of the carry-over for 2020 is composed as follows:

Description	Amount
Resources committed to cover the depreciation quotes covered by FOE starting from 2021	231,489.61
Orders issued as at 31.12.2020 but not closed at the end of the year	140,543.56
Resources committed to cover the depreciation costs for orders 2019 completed as at 31.12.2020	12,833.25
Resources committed to the project INTEGRA	2,388,736.41
Resources committed to cover investment not completed as at 31.12.2020	207,473.15
Carry over 2020 committed to ordinary activities (FOE)	1,598,802.83
Free carry over for 2019 (FOE)	798,618.09
Depreciation quotes covered by projects externally funded in the next financial years	15,532.00
Total deferred income as at 31.12.2020	**5,394,028.94**

During 2020, the residual amount of the free carry-over resulting from 2018 (€ 291,167.42) was used for the following activities:

- Financial coverage of the VAT related to the project INTEGRA (€ 85,637.46);
- Purchases order issued as at 31.12.2020 but not finalized within the end of the year (€ 140,543.56);
- Coverage of the investments referred to the internal project MAG-ALCHEMI (€ 33,066.54);
- Coverage of the depreciation costs for 2020 referred to the project INTEGRA (€ 4,270.80).

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 2020 (€ 2,804,535.00), recalculated considering the additional activities performed by Elettra-Sincrotrone Trieste S.c.p.A. (€ 46,803.52) for the spaces used by CERIC for its statutory seat, corresponds to € 2,757,731.48. The portion of the FOE 2020 spent in the current financial year corresponds to € 1.158.928,65. The remaining part of the general expenses has been covered by FOE funds 2018/2019 for € 245.691,68.

Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
2,093,084.06	2,757,731.48	664,647.42

The composition of the amount at 31.12.2020 is as shown in the following tables:

Category	31/12/2019	31/12/2020	Variation
MIUR ordinary contribution	2,293,260.46	2,757,731.48	464,471.02
FOE funds 2018/2019 spent	240,874.56	245.691,68	4.817,12
FOE funds 2019 to be spent in the following years	-1,152,980.63	-1,598,802,83	-445.822,20
Total	**1,381,154.39**	**1,404.620,33**	**23.465,94**

Category	31/12/2019	31/12/2020	Variation
FVG Region - Project PaGES	14,275.43	-	-14,275.43
H2020 ACCELERATE Project	318,034.18	222,079.58	-95,954.60
H2020 ERIC Forum Project	35,014.99	47,635.95	12,620.96
H2020 E-RIHS Project	27,966.95	15,260.88	-12,706.07
H2020 PaNOSC Project	299,025.36	414,302.79	115,277.43
Commercial services	12,950.00	15,750.00	2,800.00
Changes in inventories	-	47,826.09	47,826.09
Other incomes	4,662.76	154.39	-4,508.37
Total other incomes	**711,929.67**	**763,009.68**	**51,080.01**

Contributions for Operating Expenses

The amount of the Italian contribution for the activities of the statutory seat of the Consortium is € 1,404,620.33.

This amount covered the costs for personnel, bodies, consultancies, and other costs of the seat not covered by specific externally funded projects.

Contributions In-Kind

Representing Entity	31/12/2019	31/12/2020	Variation
SOLARIS Synchrotron (Poland)	263,454.00	-	-263,454.00
Total	**263,454.00**	**-**	**-263,454.00**

The amount indicated refers to the Polish PF IKCs calculated with reference to the Access costs. The consortium received a detailed statement of the costs incurred by SOLARIS in relation to the activities carried out in accordance with the scientific goals of the common interest between CERIC and SOLARIS. The IKCs' calculation was implemented in accordance with the methodology adopted by CERIC.

Costs

Operating Costs

Costs for Raw materials, Supplies, Consumables and Goods

This category includes costs incurred for the supply of consumables. The increase in the year is a direct result of the increased activities of the Consortium, in particular with reference to internal research grants.

Category	Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
Costs for raw materials, supplies, consumables and goods	45,792.33	47,677.44	1,885.11

Most of the total value for 2020 refers to costs incurred to support internal research grants.

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	31/12/2019	31/12/2020	Variation
External services related to the commercial activity	11,250.00	13,500.00	2,250.00
Legal, fiscal and administrative consultancy	42,025.55	33,589.89	-8,435.66
Technical consultancies	2,052.89	1,330.14	-722.75
Administrative collaborators	13,988.10	-	-13,988.10
Scientific and technical collaborators	74,336.90	146,682.03	72,345.13
Social security contributions of collaborators	31,159.35	36,262.17	5,102.82
Health contribution for collaborators	321.80	700.38	378.58
ISTAC remunerations	14,053.60	8,464.26	-5,589.34
Travel costs for employees, collaborators, and bodies	164,163.01	22,334.87	-141,828.14
Travel costs for users	63,052.38	10,231.10	-52,821.14
Expenses for corporate meetings	2,527.32	-	-2,527.32
Insurances	12,324.19	10,812.33	-1,511.86
Representation costs	2,711.67	770.90	-1,940.77
Consulting and salaries processing	16,323.31	14,025.65	-2,297.66
Mobile phones	10,199.96	8,859.39	-1,340.57
Annual software licenses	461.95	2,640.22	2,178.27
Workshops, seminars and publications	11,961.95	6,726.99	-5,234.96
Canteen expenses	17,370.00	23,895.30	6,525.30
Bank charges	2,761.02	1,879.83	-881.19
Postal charges	3,152.59	2,081.75	-1,070.84
Agreement with Universities to support PHDs	-	49,072.01	49,072.01
Maintenances	19,720.07	94,237.89	74,517.82
Training costs	7,376.43	3,434.00	-3,942.43
Transportation services	3,981.13	1,380.00	2,601.13
Other costs	15,490.73	13,067.72	-2,423.01
Total	**542,765.90**	**505,978.82**	**-36,787.08**

The item “Other costs” includes mainly costs related to transportation services, proofreading services, and other minor costs.

Personnel Costs

Personnel expenses: breakdown

Category	31/12/2019	31/12/2020	Variation
Wages and salaries	721,835.50	708,827.00	-13,008.50
Social security charges	210,313.74	218,972.86	8,659.12
Seconded personnel (IKCs against payment)	6,353.31	25,238.91	18,885.60
Severance indemnities	52,171.57	52,845.95	674.38
Allowances to be paid	60,026.46	75,029.07	15,002.61
Fellowships	10,999.98	10,999.98	-
Director	168,549.31	175,747.99	7,198.68
Social security charges of bodies	23,400.84	23,516.41	115.57
Auditors and IAEC	150,000.00	150,000.00	0.00
Total	**1,403,650.71**	**1,441,178.17**	**37,527.46**

Use of Third Party Materials or Property

No values are entered for these items

Other Operating costs

Other operating costs: breakdown

Category	31/12/2019	31/12/2020	Variation
Membership fees	2,000.00	-	-2,000.00
Rounding	284.61	244.18	-40.43
Other taxes	204.39	209.44	5,05
Other expenditures	338.61	359.10	20.49
Donations	1,000.00	2,387.60	1,387.60
Total	**3,827.61**	**3,200.32**	**-627.29**

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%	14,144.34
Total amortisation of intangible assets		**14,144.34**

Tangible Assets

Description	Depreciation Rate	Amount
Office machinery	20%	8,881.67
Equipment	15%	109,436.53
Telephony and mobile telephony	20%	644.44
Office furniture	15%	4,776.05
Total amortisation of fixed assets		**123,738.69**
Total amount (intangible and tangible)		**137,883.03**

Taxation

Current tax	Balance as at 31/12/2019	Balance as at 31/12/2020	Variation
IRAP	28,266.00	31,398.00	3,132.00
Total	**28,266.00**	**31,398.00**	**3,132.00**

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 Consortium has been evaluating the possibility to benefit from the IRAP benefits related to the COVID emergency.

The fiscal charge related to the commercial activity is equal to zero.

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 31.12.2020.

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	31/12/2019	31/12/2020	Variation
Interest on current account	401.50	413.21	124.29
Exchange rate costs	-1057.11	-727.44	-40.65
Total	**-655.61**	**-314.23**	**83.64**

Report of the commercial activities

The limited commercial activities of the Consortium have been managed through a separate account. In 2020, one commercial contract was concluded.

Revenues	
Commercial services	63,576.09
Costs	
External services related to the commercial activity	54,133.84
General costs*	31,624.37
Final balance	-22,182.12

*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 (€ 63,576.09) compared to the total amount of the revenues accounted for 2020 (€ 2,167,475.62). The ratio corresponds to 2,92%

The resulting percentage has been applied to the amount of € 1,079,339.96, corresponding to the following general cost categories, common to both institutional and commercial activities:

General costs	Amount
Executive Director	175,747.99
Auditors	87,500.00
ISTAC	8,464.26
Fiscal, legal and labor consultancies	47,615.54
Insurances	10,812.33
Utilities	8,859.39
Administrative staff	740,358.10
Total	**1,079,357.96**

Events after the reporting date

Following IPSAS 14, this paragraph reports about events that occurred between the reporting date (31.12.2020) and the date when these Financial Statements were approved by the General Assembly.
The only relevant event that occurred relates to the worldwide emergency caused by the COVID-19 pandemic. It is relevant to state that this event can be classified among the "non-adjusting events after the reporting date" and that it does not influence the assessment of the appropriate assumption of the ongoing concern of CERIC.
The temporary consequence connected to the aforementioned event could be identified in some potential slight delays in performing the activities related to the externally funded projects, for which appropriate requests of extensions could be submitted to the funding agencies.
The COVID-19 emergency might delay the organization of planned meetings and cooperation initiatives, thus affecting the use of the budget allocated to support these activities creating the necessity to postpone some expenditures. There are no valid reasons to believe that the aforementioned event could influence the Italian cash contribution from FOE, or the in-kind contributions by the Italian Representing Entity and by the other International Organisations involved in CERIC activities.

Management Report

Comparison between Final Budget and Annual Accounts

Starting from the budget for 2020 approved by the GA in November 2019, some changes were necessary as the result of the following:

COSTS and INVESTMENTS:

1. The annual redistribution of the funds related to some CERIC internal research grants;
2. The additional funds assigned to the PHDs programme during 2020;
3. The start, in December 2020, of the activities related to the batteries action plan;
4. The resources committed to the hosting costs claimed by the Italian Representing Entity;
5. The remodulation of the expenses within the project ACCELERATE.

REVENUES

1. The calculation of the actual carry-over for 2019. The 2020 budget was approved in November 2019 by the GA taking in to account an estimate of the carry-over for the year at closing.
2. Additional resources acquired in relation to a commercial contract, the refund of some expenses by third parties and interest from the bank.

Incurred and planned expenses

EXPENSES FOR 2020					
Description	Initial budget	Changes	Final budget	Total expenses	% of expenditure
CEROP	40,150.00	1,000.00	41,150.00	39,002.81	94.78
Dyna Chiro	114,000.00	-	114,000.00	25,502.47	22.37
RENEWALS	105,300.00	-	105,300.00	38,588.14	36.65
MAG-ALCHEMI	70,980.00	20,000.00	90,980.00	88,025.78	96.75
Training Projects	48,000.00	-	48,000.00	44,327.78	92.35
Collaboration Agreement IT PF and CERIC	2,725,465.00	46,803.52	2,772,268.52	2,772,268.52	100
INTEGRA	2,440,000.00	-	2,440,000.00	824,116.00	33.78
Scientific activity to be defined	1,446,905.00	656,730.00	790,175.00	126,349.08	15.99
Bodies Remuneration	400,000.00	-	400,000.00	351,934.21	87.98
Remuneration for Employees	375,000.00	115,000.00	490,000.00	486,106.34	99.21
Communication	40,000.00	-	40,000.00	19,170.40	47.93
Travel Expenses	130,000.00	-	130,000.00	14,001.87	10.77
External Services, Consultants, Consumables	339,000.00	76,054.81	262,945.19	175,104.69	66.59
Industrial Liaison & Technology Transfer	30,000.00	30,000.00	-	-	n.a.
Fixed Assets	20,000.00	-	20,000.00	7,136.51	35.68
Taxes	50,000.00	-	50,000.00	31,683.28	63.37
Activities Contributing to Strengthening CERIC	120,000.00	-	120,000.00	11,115.77	9.26
PhD Program	700,000.00	550,000.00	1,250,000.00	967,074.18	77.37
Batteries, Fuel Cells and Remotization	-	106,730.00	106,730.00	105,743.41	99.08
Commercial Activity	-	55,000.00	55,000.00	54,133.84	98.43
ACCELERATE (EU)	381,600.00	115,000.00	266,600.00	177,663.66	66.64
E-RIHS (EU)	9,600.00	-	9,600.00	1,488.31	15.50
ERIC Forum (EU)	40,000.00	-	40,000.00	35,288.75	88.22
PaNOSC (EU)	348,000.00	3,000.00	351,000.00	350,887.86	99.97
PaGES 5	10,000.00	-	10,000.00	1,337.74	13.38
TOTAL	**9,984,000.00**	**19,748.71**	**10,003,748.71**	**6,748,051.41**	**67.46**

Revenues

Description	Initial Budget	Implemented Changes	Final Budget	Accrued Revenues	%
Carry over from previous years	1,480,000.00	(35,851.95)	1,444,148.05	-	n.a.
Commercial activities	-	55,000.00	55,000.00	63,576.09	116%
FOE 2020 (CERIC)	5,530,000.00	-	5,530,000.00	5,530,000.00	100%
Carry over for 2021	-	-	-	(1,353,111.15)	n.a.
PaNOSC project	435,000.00	-	435,000.00	414,302.79	95%
E-RIHS project	12,000.00	-	12,000.00	15,260.88	127%
ACCELERATE project	477,000.00	-	477,000.00	222,079.58	47%
ERIC Forum project	50,000.00	-	50,000.00	47,635.95	95%
Carry over committed to INTEGRA	2,000,000.00	-	2,000,000.00	-	0%
Bank interests (reimbursed costs)	-	600.66	600.66	600.66	100%
TOTAL	**9,984,000.00**	**19,748.71**	**10,003,748.71**	**4,940,344.80**	

The following table includes an explanation of the difference between the actual carry-over resulting from the Financial Statements 2020 and the balance resulting from the final budget 2020.

Reconciliation between final budget and financial statements	
Description	**Amount**
TOTAL REVENUES 2020	4,940,344.80
TOTAL Expenses (contracts signed, incurred costs and investments)	6,748,051.41
Difference resulting from the budget 2020	-1,807,706.61

The exceeding amount of the planned expenses is composed by the following costs that will be represented in the Financial Statement of the following years as costs.

(+) INVESTMENTS made in 2020	623,558.96
(-) DEPRECIATION	-137,883.03
(+) PhDs agreements signed	967,074.18
(-) PhDs costs covered by FOE funds 2020	-49,072.01
(+) Contracts signed but not completed as at 31.12.2020	532,436.08
(-) Contracts 2018/2019 completed as at 31.12.2020	-128,407.57

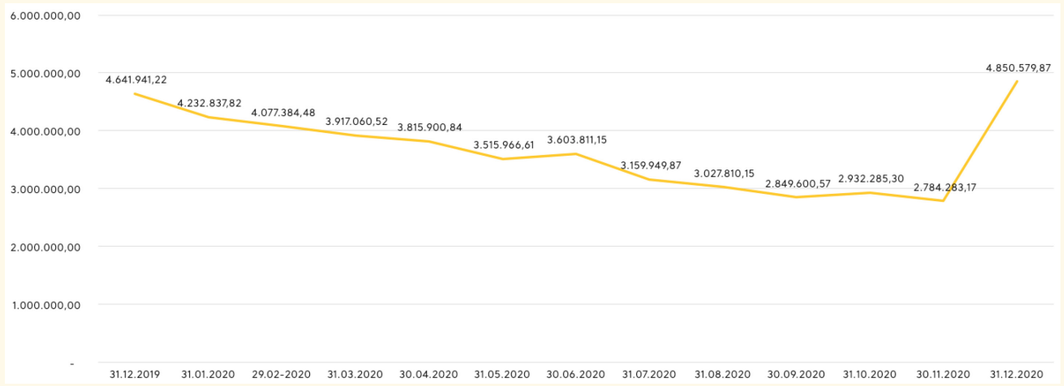
The amount of 1,807,706.61 euro is widely covered by the amount of the balance sheet item "Deferred income". This item measures the portion of the annual contribution funded by the Italian MIUR for the activities of the CERIC statutory seat deferred to the following years.

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	2020	2019
Cash flows from operating activities		
Receipts		
CERIC externally funded projects	791,652.67	95,212.50
Commercial activities	66,800.00	1,900.00
Contribution from the host country	2,804,535.00	2,404,535.00
Interest received	305.77	297.11
Other receipts	18,169.19	23,716.67
Payments		
Payments to staff	-1,286,798.85	-1,423,977.26
Suppliers	-1,181,222,00	-771,933.36
Payments to project partners	-135,116.66	-
Net Cash from Operating Activities	**1,078,325.12**	**329,750.66**
Cash flows from investment activities		
Purchase of plant and equipment	-352,440.66	-283,796.37
Sale of plant and equipment	-	-
Other	-	-
Net Cash Flow from Investment Activities	**-352,440.66**	**-283,796.37**
Cash flows from financing activities		
Proceeds from borrowings	-	-
Repayment of borrowings	-	-
Other	-	-
Net Cash Flow from Financing Activities	-	-
NET INCREASE/(DECREASE) IN CASH	**725,884.46**	**45,954.29**
CASH, BEGINNING OF THE YEAR	**5,097,254.56**	**5,051,300.27**
CASH, END OF THE YEAR	**5,823,139.02**	**5,097,254.56**

Net Financial Position - Trend for the period Jan-Dec 2020



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 credits
- - short-term 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 2020 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 2020.

Value of the PFs and in-kind contribution. Consolidated data (2020)

Total costs of the ordinary scientific/technical activities of the Partner Facilities in 2020 - COMMITTED IN-KIND									
	Recurrent costs								
PF	**Personnel costs**	**Travel & accom-moda-tion and similar**	**Consumables**	**Services**	**Utilities**	**Over-heads**	**Technical devaluation & maintenance, lease/rent costs of equipment & spaces**	**Cost of access committed to CERIC**	**Total**
AT	-	-	-	-	-	-	-	643,396.14	**643,396.14**
HR	-	-	-	-	-	-	-	33,446.57	**33,446.57**
CZ	22,296.00	-	-	-			-	319,050.62	**341,346.62**
HU	-	-	-	-	-	-	-	-	**-**
IT	300,504.27	42.60	22,246.71	11,672.92	-	-	-	3,209,532.60	**3,543,999.19**
PL	-	-	-	-	-	-	-	244,025.76	**244,025.76**
RO	15,630.00	-	3,111.43	3,126.00	-	-	77,683.12	21,980.88	**121,531.43**
SRB	-	-	-	-	-	-	-	-	**-**
SI	-	-	-	-	-	-	-	131,570.69	**131,570.69**
Tot.	**338,430.27**	**42.60**	**25,358.14**	**14,798.92**	**-**	**-**	**77,683.12**	**4,603,003.26**	**5,059,316.31**

5

CERIC Overview

The mission and main purpose of CERIC, in line with the ERIC Regulation (EC No 723/2009), is to establish and operate a multidisciplinary distributed research infrastructure 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 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 nano-scale, CERIC contributes to solving contemporary societal challenges.

CERIC is an integrated multidisciplinary research infrastructure for basic and applied research in the fields of materials, biomaterials and nanotechnology. It integrates leading national research institutes into a unique international infrastructure, having its statutory seat in Trieste – Italy, and its nodes distributed in Austria, Croatia, Czech Republic, Hungary, Poland, Romania and Slovenia (Serbia is currently pending full membership). In each country, a Partner Facility (PF) ensures access and outreach to all national scientific communities and to users from all over the world, who compete for free access to 50 techniques available through a single entry point and based on the use of electrons, ions, neutrons and photons for the analysis and synthesis of materials. This service is also open to commercial users on market-based conditions.

The governing structure involves ministerial representatives of the Member Countries, as well as the directors of the Partner Facilities. 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.

Each Member Country contributes to CERIC by making available and supporting a high-quality PF, which is continuously improved by being exposed to international users competing for access through peer-review evaluation and selection of their proposals, based on excellence. 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.

CERIC's international, pan-European approach, in line with ERIC Regulation EC No 723/2009, avoids duplication and fragmentation in the research system, and increases the integration and competitiveness of the European Research Area (ERA), speeding up East-West alignment in the ERA.

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

CZECH REPUBLIC

Charles University Prague

has expertise in surface analysis, thin film growth and studies of the reaction mechanism on catalyst surfaces. It offers Photoelectron Spectroscopy (XPS, XPD, ARUPS) with Low Energy Ion Scattering Spectroscopy and LEED, Field Emission Gun Scanning Electron Microscope, Near Ambient Pressure XPS and access to the Materials Science Beamline at synchrotron Elettra dedicated to soft X-ray photoelectron spectroscopy and NEXAFS.

HUNGARY

Budapest Neutron Centre

performs and offers R&D in nuclear science and technology, studying the interaction of radiation with matter and doing isotope and nuclear chemistry, radiography and radiation chemistry, surface chemistry and catalysis (PGAA, NAA, RAD). Neutron scattering instruments allow investigation of the microscopic properties of solids, liquids, soft materials, biological objects and condensed matter (PSD, SANS, TOF, GINA, MTEST, BIO, TAST).

ITALY

Elettra Sincrotrone Trieste

covers a wide range of experimental techniques and scientific fields, including photoemission, spectromicroscopy, crystallography, dichroic absorption spectroscopy, x-ray imaging, etc.

POLAND

Polish Ministry of Science and Higher Education

offers techniques based on synchrotron radiation: the PEEM/XAS beamline (200-2000 eV photon energy range) is equipped with PEEM - Photoemission Electron Microscopy - and XAS, devoted to spectroscopy studies by absorption of soft X-rays. The UARPES undulator beamline (8-100 eV photon energy range) is equipped with an ARPES end-station, allowing precise studies on the structure of energy bands of solids and their surfaces. The new cryo transmission electron microscope FEI Titan Krios 3Gi enables researchers to look at the macromolecules almost in their natural environment.

ROMANIA

National Institute of Materials Physics

offers access to HRTEM and EPR 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.

Abbreviations

BoD	Board of Directors
CERIC	Central European Research Infrastructure Consortium
ED	Executive Director
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
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

X-ray and Light scattering at the TU Graz and Elettra
Graz and Trieste
www.tugraz.at

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

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

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

Synchrotron and laser light at Elettra
Trieste
www.elettra.eu

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

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

NMR at the National Institute of Chemistry
Ljubljana
www.nmr.ki.si

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