

CALL FOR SUBMISSION OF DOCUMENTATION FOR THE 2021 INTERNATIONAL PEER-REVIEW ASSESSMENT OF LARGE RESEARCH INFRASTRUCTURES OF THE CZECH REPUBLIC

ANNEX 2

Besides the interim evaluation of already funded large research infrastructures, the international peer-review assessment of large research infrastructures of the Czech Republic in 2021 focuses also on the **ex-ante evaluation of new large research infrastructure project proposals** that can only be submitted in accordance with the disciplinary domains resulting from the landscape/gap analysis of large research infrastructures of Czechia, and recommended by the Research, Development and Innovation Council.

Addressing of an identified “gap” in the landscape of large research infrastructures of Czechia does not have to necessarily lead to the submittal of a brand new large research infrastructure project proposal. **Applicants who aim to fill in the identified “gaps” may cooperate with already existing facilities, thus broadening their thematic scope by infrastructural activities covering those “gaps”.**

PHYSICAL SCIENCES AND ENGINEERING

Cosmic gravitational waves detection by the U.S. – European consortium LIGO-Virgo leads to the rapid development of respective field, as well as to the experimental study of yet undiscovered astrophysical processes, including further detected objects’ and phenomena’s observations by both astrophysical and particle physics’ methods such as the astronomical telescopes and/or experiments detecting space neutrinos and cosmic radiation. The scientific field further developed when a mission of the European Space Agency (ESA) entitled LISA (*Laser Interferometer Space Antenna*) was endorsed. The progress is also linked to the development of so-called Einstein Telescope. When analysing the landscape of the large research infrastructures of Czechia in physical sciences and engineering, the area of **gravitational waves detection** was identified as a “gap”. Therefore, it appears appropriate to engage Czechia in this scientific field via participation in the already existing and/or future international gravitational waves observatories. Prospectively, it will be very beneficial to complement the Roadmap of Large Research Infrastructures of Czechia by a project to study gravitational waves and observations of their sources.

Unique apparatus for the aerospace industry – One of the fields in which both research infrastructures and companies of Czechia achieve international successes is the aviation industry. The Czech Republic is one of the few countries in Europe that can develop and build an entire aircraft or parts of an aircraft. The aerospace industry is inseparable from research and development. It is traditionally supported by a large amount of expenditures, and it also requires solutions via large projects with a high number of participants, as well as in specialised and financially extremely demanding research capacities.

Unique network of coordinated systems in industry and its environment (knowledge dynamic data and information models and digital twins network as industry high-level instruments for resilience in crisis situations) – A distinctive added value of the manufacturing sector is the concept “Industry 4.0” based on robotisation, the interconnection between the future product and implementing procedures, or the artificial intelligence involvement in all parts of the product’s life cycle. An essential prerequisite for the concept’s sustainability is to ensure the highest level of the complex industrial production chain resilience, including customer-supplier relationships, logistical arrangements, and a sufficient number of highly qualified and skilled human resources. When the system is compromised by an incident, the negative consequences for society and economy are multiplied.

Unique facilities and functionalities for engineering applications for the 21st century – According to the National Research and Innovation Strategy for Smart Specialisation of the Czech Republic, the economic performance of Czechia is based on industrial production in which fields with knowledge and technologies from mechanical engineering sector play the key role. One of the major problems, which prevents from using research and development results efficiently is multidisciplinary of research that covers all Key Enabling Technologies (KETs), as well as many other specialised fields. Whereas standard equipment, methods and expertise are available for numerous research organisations and companies, highly specialised and unique facilities and functionalities are rare in the Czech Republic.

ENERGY

From the point of view of the European Strategy Forum on Research Infrastructures (ESFRI), following themes do not have their counterpart in the system of energy-oriented large research infrastructures of the Czech Republic yet, but can be identified as strategic: (1) smart cities / smart grids, and (2) energy storage. Having regard to the **smart cities** factor, mostly, this involves smart components in buildings that combine several elements – from smart sensors and measuring instruments to innovative heating, integration of energy generation (photovoltaics), to materials developed in order to reduce the energy consumption. In this respect, the emergence of new large research infrastructure project in the form of buildings, where various user organisations would be able to examine such components, is highly conceivable. The second theme, **energy storage**, offers a whole range of possibilities – various battery systems, storage of energy in hydrogen or in a rock massif, etc. Solution for an economically available accumulation of (especially electric) energy with sufficient capacity is a requirement to further reduce the greenhouse gas emissions.

ENVIRONMENTAL SCIENCES

Regarding the portfolio of environmental large research infrastructures of Czechia, the already existing landscape does not reflect sufficiently the link to the agricultural sector and to the productive function of countryside, in general. Therefore, there is a need to focus on, inter alia, scientific areas, which may ensure the long-term ecological and biological integrity, with regard to climate change and adaptation on its impacts, by the development of applications and technologies, which would lead to mitigation of negative effects of human activities, decontamination of the environment, adaptation to the climate change, restoration and maintaining the ecosystem and biodiversity, and sustainable food production. Therefore, it seems very appropriate to pay more attention to the sustainable management of natural resources, in particular the **soil quality and water retention in the landscape** (see e.g. the role of soil in the global CO₂ accounting and in biodiversity conservation), including **geological environment and mineral resources**. The reason for that is a need of sufficient information so that the conservation and sustainable use of soil (i.e. prevention of further soil degradation, preservation of soil functions and restoration of degraded soils) can be ensured. At the same time, other issues like **wildlife ecology** (of both plants and animals) with causal factors operating on them and/or landscape changes in terms of the **ecosystems impacts** (beyond currently addressed climate change) arise. An important area, which has the potential to bring up a relevant knowledge for agricultural production, appears to be breeding of new varieties of plants, which are able to adapt to the climate change, but also breeding of plants, which are resistant to harmful organisms. Therefore, one of the expanding fields is **plant phenotyping** to measure structural and functional plant characteristic. The European Strategy Forum on Research Infrastructures (ESFRI) lists the **EMPHASIS** (*European Infrastructure for Multi-scale Plant Phenomics and Simulation*), focusing on the development and the provision of access to equipment and services concerned with the plant phenotyping in different agro-climatic scenarios, as a key priority project of the European environmentally oriented research infrastructures landscape. It is, therefore, desirable for the Czech Republic to be involved in its implementation in the following years.

The area of environmental sciences should also have much stronger focus on the industry's long-term sustainability by reducing its negative impacts on the environment. In the framework of sustainable management of natural resources, a concept of the circular economy should be developed, e.g. in the field of **water use efficiency in the industrial production**. **Industrial chemistry** research is also crucial since the industrial chemistry is an indispensable supplier for many subsequent sectors, e.g. chemical recycling, use of modern fuels and further "greening" of production, including use of renewable energy resources or energy conservation. **Building industry** from the perspective of the introduction of new processes, materials or digitisation of activities aimed mainly at the BIM concept (*Building Information Modelling*), which works with the entire lifetime of constructions from the preparation of the project to the (ecologic) demolition, may be identified as related topics.

HEALTH AND FOOD

Biological and medical research infrastructures, listed in the most recent 2019 update to the Roadmap of Large Research Infrastructures of the Czech Republic, cover a wide range of scientific disciplines – from the fundamental research with a systems biology approach to translational and clinical research, which allows the new scientific evidence to be implemented in clinical practice. Strategic building up the biological and medical large research infrastructures in their entirety is crucial for effective use of funds invested in scientific excellence, as well as for maximising the use of its potential in applications. Capacities of the CCP, CZ-OPENSREEN, CIISB and NCMG large research infrastructures form a vital backbone network for the fundamental biomedical research at an early stage of the drug development. The CZECRIN, BBMRI-CZ and EATRIS-CZ large research infrastructures then represent an interoperable network of scientific bodies that play a part in translational and clinical research in the Czech Republic, and, being clinically orientated, they have huge potential to increase the efficiency of the fundamental biomedical research by the translation of its results into the clinical field. Furthermore, the biomedical large research infrastructures' landscape of Czechia is complemented by integrative services of Czech-BioImaging and ELIXIR-CZ, which provide facilities for biological and medical imaging and resources for data processing, analysing and archiving in the field of life sciences. The area of food and nutrition is covered by the METROFOOD-CZ large research infrastructure that specialises on numerous agri-food sector themes from agricultural production of food raw materials and technology of their processing, to food analysis focused on food security, authenticity and its nutritional, hygienic, technological and sensory quality. Within the framework of the large research infrastructure landscape analysis, no other "gaps" were identified. Nevertheless, the lack of the **Czech national node to the EMPHASIS** (*European Infrastructure for Multi-scale Plant Phenomics and Simulation*) European research infrastructure may be considered as a certain weakness.

SOCIAL SCIENCES AND HUMANITIES

Technologically innovative analytical instruments allowing for reducing the invasiveness of processes and offering new possibilities in terms of the research sensitivity, deepness and complexity, support research of objects of the cultural heritage as well as help their protection. The use of such instruments affects also increase of data production, sharing and accessibility. At the same time, close cooperation between humanities, natural sciences and technology area takes place. The **E-RIHS** (*European Research Infrastructure for Heritage Science*) project, included in the Roadmap of European Strategy Forum on Research Infrastructures (ESFRI), represents a multidisciplinary research infrastructure in the European Research Area, which integrates archives of scientific information services, virtual platforms for data access, and accelerators, synchrotrons, neutron sources and other analytical instruments used to study and protect the cultural heritage. If the Czech Republic was, based on the systematic use of the already operating Czech capacities in the form of multidisciplinary research infrastructure for cultural heritage studies and protection, involved in E-RIHS, it would have a positive impact on the competitiveness of many fields of humanities, as well as on the Czech Republic's cultural heritage protection.

Study of family life, strategies, attitudes and peoples' behaviour towards family-planning, parenthood, childcare, care for elderly family members, housing, ageing, behaviour on labour market etc. may bring solutions to challenges, which modern societies face in the fields of population development, changes in the labour market, gender and social inequalities, affecting thus competitiveness, as well quality of life. The **GGP** (*Generations and Gender Programme*) European research programme supports studies in these areas continually by the data, which are unique in terms of the panel survey design (repeatedly uses of the same sample of respondents) and the number of participating countries, and they offer an exceptional opportunity to study course of life and family dynamics in an international and historical comparison. Participation in the form of large research infrastructure for population studies and family dynamics, which would give continuity to previous Czech participation in 2005–2010 and allow for the Czech continuous involvement in GGP, may significantly improve analytical support for solving above-mentioned issues in the Czech Republic within the European context.

Dynamic social, economic, demographic and political changes, growing social inequalities, the issue of equal opportunities, social polarisation and social conflicts are amongst the main challenges of modern societies. To study those processes, the data are needed not only at the individual level, but also at the level of households and families, being basic social units in which interaction amongst family members leading to the formation of one's values and attitudes, decision on the educational path, labour market participation or allocation of time takes place. Demographic, economic, educational, as well as political processes are, thus, closely interrelated, and their understanding requires a multidisciplinary approach with the broad evidence base, which is not restricted to a particular field of **social life**.

EHRI (*European Holocaust Research Infrastructure*) is a European research infrastructure established in 2010 and aimed at facilitating access to data and information on various information resources on Holocaust-era to the research community, as well as at the development of methods and instruments for working with the resources. The main EHRI challenge is to overcome the fragmentation of relevant resources and associated historiographical research, and to integrate them in such a way as to study the Holocaust as a pan-European phenomenon. Therefore, in principle, the research is historiographic, but with regards to a certain amount of resources in digital form, methods from *digital humanities* are being applied too. The EHRI project is listed in the Roadmap of European Strategy Forum on Research Infrastructures (ESFRI). Its implementation stage is envisaged for 2021 with the operational phase to be launched in 2021. The Czech involvement in EHRI would certainly contribute to awareness of the Holocaust studies in the European dimension.

e-INFRASTRUCTURES

The e-INFRA CZ e-infrastructure – a consortium consisted of e-infrastructure CESNET, IT4Innovations and CERIT-SC, is a comprehensive, and at the Czech national level a unique system of ICT components and services providing capacities and resources for scientific data transmission, storage and processing that are essential for modern research, development and innovation. The e-INFRA CZ consortium is involved in all the important areas of e-infrastructure both at European and global levels, and it fully covers all the research, development and innovation demands in the Czech Republic. Having regard to the already carried-out integration into one consortium project, in the forthcoming period, there is no need to establish a new e-infrastructure in Czechia. Nevertheless, it is necessary to ensure e-INFRA CZ development in all crucial directions. The areas of key interest are: (1) highly functional communication e-infrastructure – implemented in connection with GÉANT; (2) the most advanced computing systems – implemented in relation to the EuroHPC initiative; (3) distributed computing and storage capacities and services – implemented in connection with the EOSC initiative (*European Open Science Cloud*); (4) development of principles for handling heterogeneous and big data with extensive use of the artificial intelligence tools; (5) new technology areas, such as application of quantum technologies. At the same time, it is perceived as necessary to open a debate on the possibilities how to use the e-INFRA CZ for needs of public sector research, and how to use e-INFRA CZ capacities for needs of large computational tasks that take place within Governmental authorities, and on the related cooperation financial model.