

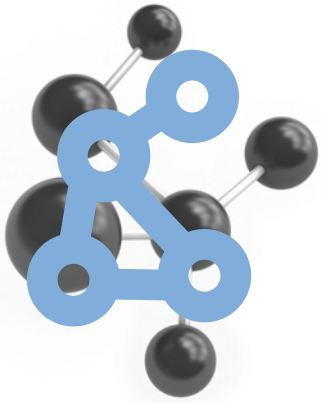


Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic

May 2011 Update

Ministry of Education, Youth and Sports

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

2007–13
OP Výzkum a vývoj pro inovace

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Contents

Introduction

part A

1. The Updated Roadmap What Is New?

The update to the 2010 version of the Roadmap for Large Research, Development[1] and Innovation Infrastructures in the Czech Republic (hereinafter the "Czech Roadmap") supplements the text of the first version[2], which was approved by Government Decree No. 207 of 15 March 2010, with information obtained through the developments that have taken place with regard to large infrastructures between 2010 and 2011. As is the case with the original version, this update is based on the concepts contained in the European Roadmap for Research Infrastructures (the ESFRI Roadmap).

In 2010, steps were taken at the national level to strengthen the strategic approach for large research, development and innovation infrastructures (hereinafter "large infrastructures"). The Ministry of Education, Youth and Sports (MEYS) established the Council for Large Infrastructures (hereinafter the "Council"). The Council's primary tasks consist of evaluating the infrastructure proposals submitted for financing and performing an assessment of the strategic steps taken by the Czech Republic at the national and European levels.

At the start of 2010, the government approved the first fifteen large infrastructure projects for financing.[3] This launched the implementation stage of the Czech Roadmap. Prior to this time, large infrastructure projects were financed either from the INGO Programme in the case of facilities and equipment located outside of the Czech Republic or through the Centre for Basic Research and Research Aims in the case of national infrastructures. The projects approved by the government for financing interconnect the national research platform with the European platform and integrate the Czech Republic in the European Research Area.

[1] In accordance with Section 2 (1)(c) of Act No. 130/2002 Coll., on support for research, development and innovation from public funds and amendments to certain other legislation (the Research and Development Support Act), the entire text uses "development" as the simplified term for "experimental development".

[2] The Czech and English versions of the Roadmap are accessible at: http://www.msmt.cz/vyzkum/schvaleny-text-cestovni-mapy.

[3] The following projects were approved: BBMRI, CESNET, CESSDA, CzechCOS/ICOS, CzechGeo/EPOS, CzechPolar, CZERA, ESS, ESS – Survey, JHR, LINDAT/CLARIN, PALS, Řež Reactors, SHARE, and ThALES.

There was also an important move forward with regard to the Structural Funds in 2010. The first financing was provided for some of the regional projects submitted under the Research and Development for Innovation Operational Programme (RDI OP). Some of these projects are of an important infrastructural nature, such as BIOMEDREG. Out of the Structural Funds allocated for Prague, financing was provided to the SAFMAT project (nanomaterials) and to the Czech portion of the EU-OPENSCREEN project (biomedicine). Major individual RDI OP projects, specifically the ELI, Sustainable Energy, CEITEC, ICRC, IT4Innovations, and BIOCEV projects, underwent the evaluation process at the national level and were sent to the European Commission for assessment. The ELI Beamlines project was the first to receive a decision from the European Commission (in April 2010). The decisions for the remaining major projects are expected to be issued by no later than the third quarter of 2011.

The majority of states started to suffer from the impact of the financial crisis in 2010, which, in the case of some states, was reflected in their efforts to decrease public financing, often at the expense of the funding allocated for research. The resulting atmosphere is one in which research results are critically evaluated, including the impact of large infrastructure operations. At the European level, the ESFRI Infrastructure Evaluation Group has started the task of reviewing the existing procedures and proposing possible evaluation methodologies for those infrastructures that are classified as relevant for the European Research Area. The European Commission also voiced its support for the MERIL project, which is aimed at creating a European portal for research infrastructures, whether they are international or national infrastructures with European scope and importance. As a result of this activity, the question arises as to whether it might not be appropriate to create a detailed "List of National Large Infrastructures", which would be considered as irreplaceable for the purpose of research, development and innovation in the Czech Republic. In addition to preparing a list of large infrastructures based on certain predefined characteristics of a large infrastructure, it is also necessary to clarify the relationship between the Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic and the specifically targeted financing for certain large infrastructure projects. The MEYS Council for Large Infrastructures will take on the responsibility for this task in 2011. In the future, it can be expected that certain projects will be integrated into the Czech Roadmap and that new projects will be defined according to the manner in which research organisations respond to their specific needs and requirements for basic research. A fairly new trend can be seen in the fact that some of the infrastructures are no longer field-specific, but tend to serve several scientific disciplines concurrently.

It is important to emphasise that large infrastructures play an integrative role in the fairly fragmented administrative system that is in place in the Czech Republic for supporting research, development and innovation. The involvement of Czech teams in the work performed at foreign large infrastructures and the inclusion of Czech infrastructures in the European Research Area (ERA) are reflected in the excellence of the CR's research efforts. Both of these facts should be taken into account when implementing the Czech Roadmap.

The support provided for large infrastructures is an inseparable component of the broader EU effort to improve Europe's competitive strength. The Europe 2020 Strategy approved by the European Council as a part of the Innovation Union Flagship Initiative places emphasis on completing the European Research Area. All of the large infrastructure projects make a significant contribution towards this goal.

One of the goals for the Innovation Union is to start or complete 60% of the high-priority research infrastructures described in the ESFRI Roadmap by 2015. In addition, the operational programmes submitted by the individual member states should be reviewed in order to facilitate the use of Cohesion Policy funds for this purpose.

Another key European topic addresses the creation of synergy between the Cohesion Policy and the future strategic framework for financing research and innovation at the European level; strengthening the mobility of research infrastructure workers, even those holding technical positions; and the possibility of using large infrastructures to meet the needs of today's society.

Project Selection Criteria

In order to be included in the updated Czech Roadmap, the same criteria were used as for the previous version in accordance with the definition of a "large infrastructure" as set out in Section 2 (2)(f) of Act No. 130/2002 Coll., on support for research, development and innovation from public funds and amendments to certain other legislation (the Research and Development Support Act). These criteria are as follows:

- A large infrastructure contributes towards fulfilling the priorities defined for applied research, development and innovation in the CR for the 2009-2011 period.[1]
- A large infrastructure is a unique set of facilities and activities that have costly operations.
- A large infrastructure is essential in order to ensure the quality of basic research. The research that is performed using the infrastructure must attain a level of scientific, technical or methodical excellence. It must help to generate a critical number of material, financial and human resources and it must also be of key importance for research and development at both the national as well as the European levels.
- A large infrastructure plays an important role in the overall strategy of the development field in which it is active.
- A large infrastructure provides "open access", i.e. it is accessible to the entire scientific community and provides research services to external users on the basis of tenders evaluated by independent experts, who look at the quality of the project that is submitted as the main selection criterion.
- A large infrastructure is linked to the RDI OP projects (the construction phase is completed using financing from the Structural Funds).
- A large infrastructure is linked to the projects contained in the ESFRI Roadmap and is integrative in nature.
- In addition to performing research and development activities, a large infrastructure facilitates knowledge transfer (training and education for students, doctoral candidates, postdoctoral researchers, scientists and other experts, as well a link to the consumer sector).

Thematically focused working groups used the above criteria to evaluate the submitted project proposals. The fact that a project is included in the Czech Roadmap does not in any way guarantee that the project will be implemented or that any financing will be provided for the infrastructure's operations.

The projects that are included in the Czech Roadmap are further separated into **high-priority** projects and **promising projects** according to the following criteria:

The projects that are classified as high-priority involve:

- infrastructures that already exist and are in operation;
- infrastructures that are included in structural fund projects for which a grant has been provided;
- infrastructures that are included in structural fund projects that have already been evaluated at the national (or national and international) level and for which the negotiations have led to positive results; and
- projects that link the above-mentioned to an international network or at least to a distributed European infrastructure.

The project proposals that are classified as promising include:

- proposals that are included in structural fund projects, which have undergone the national evaluation process and will enter into the negotiation phase by 1 May 2011 in the case of RDI OP projects; or
- proposals included in structural fund projects, which are in either the evaluation phase or in the project objective definition phase; and

[1] The priorities for applied research are in included in the National Policy for Research, Development and Innovation for 2009-2015, which was approved by the government by Decree No. 729 of 8 June 2009 (http://www.vyzkum.cz/).

- other projects based on the proposals submitted by the thematic groups (including those that still need to better define the specific large infrastructure that is involved).

One exception to the above rules consists of the RDI OP CV-VOZE and INEF energy projects and the major Sustainable Energy project, which have already been approved, but have been reclassified as promising rather than high-priority based on a recommendation made by the peer review group. The reason for this reclassification is that it is currently difficult to determine whether they truly involve large infrastructures or not.

2. The Structural Funds and Their Use for Establishing Large Infrastructures

Many public and private institutions involved in research, development and innovation in the Czech Republic currently face problems associated with the limited capacity of research facilities, insufficient material means, the loss of talent to facilities abroad, a lack of specialised personnel, and insufficient cooperation with the application sector.

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The Czech research environment currently faces a great challenge, as the Structural Funds provide an opportunity to use European Union funds and to convert them into the realisation of scientific objectives and plans, thus contributing to the Czech Republic's integration in the European Research Area.

As far as the Structural Funds are concerned, during the 2007–2013 period, the Czech Republic is drawing from twenty-four operational programmes, two Interact II programmes (service programmes designed solely for the use of the operational programme management structures under Objective 3), and the ESPON 2013 programme, all of which are focused on supporting research and development for territorial planning and regional development. These programmes are divided between three different objectives for economic and social cohesion policy, specifically the Convergence Objective, the Regional Competitiveness and Employment Objective, and the European Territorial Cooperation Objective.

Seven regional operational programmes, which aim to support regional development (NUTS 2), and eight thematic operational programmes have been defined for the Convergence Objective. One of the thematic operational programmes for the regions is the Research and Development of Innovation Operational Programme (RDI OP), which is focused on strengthening the Czech Republic's competitiveness and on creating highly-qualified jobs through better defining the conditions required for the existence and operation of research, development and innovation centres, universities and others. The RDI OP provides support for increasing the capacity of existing research and development centres, for the establishment of new institutions in the Czech Republic's regions, and for accelerating the transfer of research and development results into practice and their introduction in the industry sector and on the market.

EUR 2.43 billion has been allocated for this operational programme, of which 85% (EUR 2.07 billion) consists of financing from the European Union and 15% (EUR 0.36 billion) is financed from the Czech Republic's national budget. The period during which this funding must be used has been set as 2007 to 2013 or 2015, as applicable.

Large infrastructures of pan-European importance are eligible to receive financing primarily within Priority Axes 1 and 2. One of the most essential steps with regard to defining projects that have an international impact was the "pre-call" for the submission of major projects[1] for the RDI OP, which took place in July 2008. The key selection criteria required a partnership with an ESFRI research infrastructure and a link to the Seventh Framework Programme. In November 2009 calls were published for the submission of projects for Priority Axes 1 and 2. Certain major projects were submitted for these calls in addition to standard projects. The implementation of major projects is subject to the approval of the European Commission in Accordance to a Council (EC) Directive. The following projects were submitted for Priority Acid 1 and received a positive response: BIOCEV, CEITEC, ELI, FNUSA-ICRC, and IT4Innovations. The Sustainable Energy project was submitted for Priority Axis 2. BIOMEDREG and CzechGlobe are two examples of projects that have a European dimension.

A description of the projects is provided below.

ELI – Extreme Light Infrastructure

The ELI project, which will be implemented in Dolní Břežany, is included in the European plan for developing the next generation of large research facilities as identified and selected by ESFRI. The ELI project will result in an international research facility that will use innovative laser technology to generate the most intense light beams in the world. The ELI Research Centre will be a pioneer in many research areas that use ultra-intense lasers. As far as the Czech Republic is concerned, it represents a unique opportunity to host an important international research infrastructure. The mission of the ELI project incorporates not only basic academic research, but also applied research that has a direct social impact. The primary aim of the ELI project is to build the world's most modern laser facility, thus making it possible to implement a number of research and application projects that use intense light interactions under extreme material conditions.

[1] A "major project" is defined as a project for which the total expenditure (eligible and non-eligible) exceeds EUR 50 million.

BIOCEV – Biotech & Biomed Research Centre

BIOCEV is a joint project of the various institutes that fall under the Academy of Sciences of the Czech Republic (specifically the Institute of Molecular Genetics, the Institute of Microbiology, the Institute of Physiology, the Institute of Experimental Medicine, the Institute of Biotechnology, and the Institute of Macromolecular Chemistry) and the Charles University as represented by two separate faculties (the Faculty of Sciences and the First Faculty of Medicine). The Centre will be established in Vestec in the Central Bohemian Region, a region which is suffering from an outflow of the workforce to Prague. This project for creating a biotechnological and biomedical centre has ambitions of becoming a European centre of excellence, which will concentrate teams of renowned experts, who have thus far been scattered across several partnership workplaces of the Academy of Sciences of the Czech Republic and Charles University, and will supplement them with teams of young scientists and experts from abroad. BIOCEV will help to close the gap that currently exists in the professional environment for developing the advanced biotechnological industry in the Czech Republic. The BIOCEV project includes the Czech portion of the project for developing the ESFRI INFRAFRONTIER and Euro-BioImaging infrastructures.

CEITEC – Central European Institute of Technology

CEITEC will provide an environment for excellent research and for post-graduate and doctoral studies in the disciplines of nanotechnology, microtechnology, molecular biology, genomics, and proteomics and their application in the fields of advanced materials and medicine. The cutting-edge technology that is used will facilitate the synergistic study of the earth and life sciences at all existing levels of complexity, starting with individual atoms, molecules and molecular groups, up to entire organisms. The CEITEC project is built on the mutual synergy that exists between seven research programmes. The project partners comprise Masaryk University, the Brno University of

Technology, the Mendel University in Brno, the University of Veterinary and Pharmaceutical Sciences in Brno, the Veterinary Research Institute, and the Institute of Physics of Materials of the Academy of Sciences of the Czech Republic. As a result of the broad range of disciplines that are covered, the CEITEC infrastructures fall within two thematic areas of the Roadmap – material physics and space (the areas of the CEITEC project dealing with nanostructures and advanced materials) and biomedicine (which covers the Czech portion of the INSTRUCT project, participation in the EuroBioimaging infrastructures, and the Czech Centre for Medical Genomics).

IT4Innovations

The global objective of the IT4Innovations project is to establish a national centre of excellence for information technology research in the Czech Republic. The project includes the creation of a research environment, including adequate infrastructure, focused primarily on academic IT research associated with the development of computational methods and, in particular, on ways in which IT can be effectively used for further research or in the application sphere. The main investment will consist of a high-performance supercomputer, which is a key condition for the implementation of the research plan for the IT4Innovations Centre of Excellence, including the means for maintaining the centre. The supercomputer infrastructure will be accessible to a wide range of users and will be connected to e-infrastructures at both the national as well as the European levels, primarily through the CESNET Association and involvement in the Partnership for Advanced Computing in Europe (PRACE) infrastructure activities. Five research organisations are the project partners and have contributed research capacities, which are active and are achieving results in the areas covered by the IT4Innovations project, specifically these are the Vysoká škola báňská – Technical University of Ostrava, the Institute of Geonics of the Academy of Sciences of the Czech Republic, the Brno University of Technology, the University of Ostrava, and the Silesian University in Opava.

Sustainable Energy

The key objective of the Sustainable Energy project is to develop two regional research centres (in the NUTS 2 Southwest and NUTS 2 Central Bohemia Regions), which will perform experimental development and innovation in the field of long-term sustainable energy as an essential condition for improving the competitive strength of the Czech economy. The goal is to establish a centre for performing theoretic and experimental research in the area of procedures and materials, including their subsequent practical application, in the interest of attaining an acceptable level of safety and environmental impact for energy facilities, particularly facilities that use nuclear processes. This will facilitate the gradual replacement of traditional processes that are dependent on coal and crude oil, thereby increasing effectiveness, decreasing production costs, reducing CO2 emissions, and recycling the greatest possible amount of raw materials. The Sustainable Energy project has been conceived on the basis of the objectives defined in the EU's energy policy and the goals of nuclear energy technological platforms and has been designed in a way that will make it directly usable for European research initiatives and will allow the subsequent in-kind participation of Czech industry in large demonstrative projects (in particular, the use of the most modern Generation III+ and IV nuclear reactors). This will help to guarantee the prerequisites for expanding the export potential of Czech industry in areas that have a high added value and significant market potential.

FNUSA-ICRC – St. Anne's University Hospital in Brno – International Clinical Research Centre

The goal of the FNUSA-ICRC project is to establish a top-quality international centre for applied medical research, which will use the most contemporary methods for cooperation in order to speed up the development of breakthrough medical and diagnostic techniques, new technologies (including biotechnologies and nanotechnologies), and new medications by at least 50%. The FNUSA-ICRC project represents the culmination of almost ten years of successful cooperation in medical research between the experts from the St. Anne's University Hospital in Brno and the Mayo Clinic in Rochester, Massachusetts, USA. The concept for the proposed ICRC project is based on the more than four decades of experience that the Mayo Clinic has with operating its own clinical research centre – the General Clinical Research Center (GCRC). Currently the Mayo Clinic is the main strategic academic partner for the project. The ICRC will be focused primarily on cardiovascular and neurological research with possible overlap into other fields.

3. Cooperation with Industry and Universities

Large infrastructures play a key role in providing an environment for talented young scientists and leading researchers. As they are a meeting place for students, academicians and research and development employees from the industry sector, large infrastructures represent an effective platform for the open and direct exchange of skills and knowledge.

In the case of large infrastructures, the transfer of technologies to the application sphere is accomplished by, amongst other things, technological clusters and spin-off companies or through technological parks built in close proximity to large infrastructures. This makes it possible to develop the innovation potential of the Czech and international companies that are linked to large infrastructures in this way.

The direct involvement of industrial companies in large infrastructures occurs in the form of building activities during the construction phase and also due to their involvement in the manufacture of highly specialised components for the measuring equipment that is used by large infrastructures. During the operational phase, industrial companies are involved in the maintenance and renewal of large infrastructures. Additionally, industry uses the service provided by large infrastructures and the measurement results are used for developing innovative products.

Experience with large infrastructures from abroad provide an estimate of the long-term economic rate of return from large infrastructures that is based on approximately 70% of the operating costs (personnel expenses, supplies and technical equipment) being invested in the local economy where the infrastructure is located. The support provided for establishing and developing large infrastructures in the regions, the establishment of new educational infrastructures and their reconstruction, including the involvement of the public research and development sector in meeting the requirements of the application sector, leads to a gradual improvement in innovation capacity and the final use of research and development results. The involvement of partners from the research and application sectors contributes towards realising the strategic focus of public research, towards supporting entrepreneurial activities and the use of intellectual property rights, and towards the transfer of technologies and the commercialisation of research and development results.

Large infrastructures have an indisputable impact on human resource development in research. The ability to study combined with the opportunity to work in the creative and motivating environment that is provided by large infrastructures attracts university students and professors alike. The consortiums that are created lead to close cooperation between large infrastructures and universities in the form of educational programmes. One of the specific characteristics of large infrastructures is that they are also used by national and international research teams to find solutions to key research and development projects. As large infrastructures bring students into contact with representatives from the industry sector, they contribute towards inter-sector mobility and the employment of students in the research and development divisions of industrial companies.

Distribution of Large Infrastructures according to Research Focus

part B

The following material provides an overview of the current strengths and weaknesses, strategic procedures and the selection of projects according to the specific focus of the research that they support.

1 Social Sciences and Humanities (SSH)

1.1 Current Status

Research in the social sciences and humanities (SSH) is characterised by a long-term dramatic increase in production and in the use of data. One of the conditions for its effectiveness consists of the sharing and the multiple use of data as 1) the research value of data exceeds the boundaries of individual projects; 2) the costly generation of databases requires concentrated resources; and 3) the integration of databases leads to the creation of new research material..

The need to create databases, to perform longitudinal research, and to improve the accessibility of existing data resources for research purposes within various fields of SSH and to increase its ability to make a contribution to social development is documented in, amongst other things, the National Research, Development and Innovation Policy of the Czech Republic for 2009-2015 (Section III Chapter 2.8). Key priorities in SSH include the study of social development and the preservation of the national memory. These lead to the necessity for the long-term systematic collection of data and the cumulative gathering of material. Irreparable damage will result if there is an interruption in the process, if it is unsystematically performed, or if archived materials are lost. The long-term sustainability of a number of activities is thus vital for the success of both current as well as future research. The effective fulfilment of these needs lies in the development of large infrastructures.

Digitalisation, the introduction of new technologies and the use of the internet to improve access to databases have changed the way research is organised in many fields. The number of options available for using various types of data is growing at a consistent rate, analytical methods are changing and the possibilities for cooperation based on shared data are increasing. Data from scientific research is increasingly more accessible for higher education at universities. The conditions for attaining excellence in research are being created in the regions. Modern large infrastructures are therefore a key prerequisite for the competitiveness of Czech research in the social sciences and the humanities and for its involvement in international cooperation.

The processes required for continuous database generation and maintenance, for the integration of scattered data sources, and for establishing access to data exceed the scope of individual research institutions and even extend beyond national boundaries. Distributed large infrastructures are commonly used. Infrastructures in SSH are typically also associated with high demands on qualified labour, whilst investments into technical equipment tend to be lower.

The SSH research infrastructure in the Czech Republic is however often fragmented into a large number of sources of a small scope and with various levels of accessibility. The projects specified in the Czech Roadmap all contribute towards rectifying this unsatisfactory situation by integrating data sources and/or by focusing on the systematic continuous generation of databases. Their primary objective consists of the long-term provision of public access to large infrastructures that are unique within one or more fields and which offer wide-scale application potential with significant links to international research at a high level of intensity and with broad scope of activities. The impact these projects have on education and applied research is also taken into account.

The update to the Czech Roadmap with regard to SSH incorporates the implementation steps taken for the high-priority projects in 2010. The project for establishing a Czech Infrastructure for Egyptology has been added as a promising project. The following paragraphs present an overview of the current status of Czech large infrastructures in the social sciences and humanities.

The Bibliography of the History of the Czech Lands (BHCL), a project of the Institute of History of the Czech Academy of Sciences, is a long-term programme for creating a publicly accessible electronic database containing information on Bohemian (Czech) literature in the field of history and related sciences and which provides analytical and research services. The project also adds Czech data to international bibliographic databases. The LINDAT-CLARIN Linguistic Data Centre is a joint project of the Institute of Formal and Applied Linguistics of the Charles University Faculty of Mathematics and Physics and its partner institutions (the Institute of Czech Language of the ASCR, Masaryk University in Brno and the University of West Bohemia in Pilsen). This project combines the objectives of interconnecting and providing access to language resources with the development of language technologies and aims to serve as a centre that is integrated into the large European-wide Common Language Resources and Technology Infrastructure (CLARIN), which was established within the ESFRI framework. The European Social Survey (ESS) is a long-term international programme that is included in the ESFRI Roadmap. It is aimed at continuously monitoring the indicators that are used for researching the interaction between the institutions in an ever-changing Europe and the attitudes, beliefs and behavioural models that exist within various population groups. The Institute of Sociology of the ASCR has been in charge of the Czech Republic's participation in this project since 2002. The Survey of Health, Ageing and Retirement in Europe (SHARE) is a longitudinal multidisciplinary investigative programme that was established in 2004. It aims to create an international comparative database containing information about the situation of the elderly and society overall throughout Europe. The Czech Republic's participation in this programme has been headed by the Economics Institute of the ASCR. The Czech Social Science Data Archive (CSDA), formerly known as the Sociological Data Archive (SDA), of the Institute of Sociology of the Academy of Science of the CR collects socioeconomic research data and makes this information accessible to the public. It also provides an appropriate environment for large international and repeated surveys and functions as a central node of the Council of European Social Science Data Archives (CESSDA), within the framework of which it will participate in the preparation of the common European system for data services that is included in the ESFRI process. The Institute of the Czech National Corpus (ICNC) of the Charles University Faculty of Arts is focused on establishing, maintaining, researching and providing public access to the most extensive general database of the Czech language, both past and present. A number of national and institutional institutions are partners for this project.

1.2 SWOT Analysis

Strengths

- The extensive production of data suitable for sharing;
- Participation in prestigious international large infrastructure projects;
- A long tradition of summarisation and archiving activities; and
- A well-developed IT infrastructure and access to new technologies.

Weaknesses

- Long-term underfinancing and insufficient funds for operation pose a threat to continuity;
- A low capacity offered by the services of the existing infrastructures;
- Fragmentation, insufficient coordination, concentrated and interconnected resources, and mutually incompatible systems;
- The non-existence of longitudinal data and a discontinuity in the implementation of long-term research studies; and
- Frequent inadequate accessibility.

Opportunities

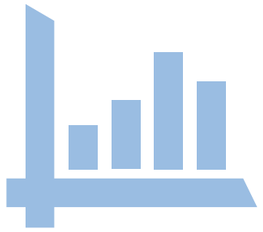
- Strong demand within both basic as well as applied research;
- The openness of the Czech scientific community with regard to sharing resource materials;
- Opportunities for cooperation within international networks, accompanied by the effectiveness that results from the sharing of resources and costs;
- The realisation of high-priority policies that support international cooperation, education, regional development and applied research and which help to ensure the effectiveness of public investment in research; and
- Compliance with the European Union's priorities.

Threats

- An ongoing lack of sufficient financing;
- A lack of knowledge and preparedness with regard to new opportunities and new financing mechanisms;
- Possible disruptions in the environment for cooperation in research and the sharing of research data;
- A non-existent or inappropriate methodology used for evaluating large infrastructures; and
- The incompatibility of local conditions with the obligations that exist in international networks.

Proposed Solution:

As far as the large infrastructures for SSH are concerned, it is necessary to introduce a conceptual policy based on the long-term financing requirements of the aforementioned types of infrastructures, as the importance of research in the social sciences and humanities is greatly dependent on the ability to compare data from the long-term perspective. In addition to projects that ensure the incorporation of the Czech environment in the European Research Area, it is also appropriate to support projects that will decrease the fragmentation of the Czech infrastructures and will facilitate interdisciplinary research.



1.3 High-Priority Projects

The following are existing infrastructure projects and projects that are of pan-European importance which are in the preparatory phase:

BHCL

BHCL – Bibliography of the History of the Czech Lands – is an ongoing project for creating, processing and evaluating a comprehensive bibliographic database of Bohemian (Czech) literature, which will use contemporary methods to continue the activities started in 1905. This database is one of the most important resources for history and the associated sciences (archaeology, ethnology, monument preservation, historical geography and cartography, historical onomastics and toponymy, historical demographics, etc.). The BHCL: 1) generates a database and provides public access to it; and 2) publishes bibliographic catalogues and annual almanacs and perform searches. The BHCL project also transfers data to international ERA databases, participates in international data exchange programmes, and is involved in the project to interconnect the databases of the European Historical Bibliographies. The BHCL project uses modern technologies and the level of the services it provides are ranked amongst Europe's best. The BHCL is an existing infrastructure operated by the Institute of History of the ASCR.

CESSDA

The **CESSDA (Council of European Social Science Data Archives)** ESFRI project is developing a common European data service system for socioeconomic research. By interlinking the national archives currently included in the existing CESSDA network, access will be provided to data resources without regard to where in the ERA they are physically located. This will have a significant positive impact on the opportunities to participate in international comparisons, the expansion of data resources, a methodological environment, and an increase in the quality of provided services. In order to integrate the Czech Republic into the newly originating CESSDA European Research Infrastructure Consortium (CESSDA-ERIC), a "connecting node" to the European distributed large CESSDA infrastructure will be created within the existing Czech infrastructure, specifically the Czech Social Science Data Archive of the Institute of Sociology of the ASCR (refer to Section 5.1.1 above), which has been providing open access to social science data in the Czech Republic since 1998 and which has been a member of the CESSDA network since 2001. This project will significantly strengthen data services in the CR and improve the international integration of Czech social science research. Data archives provide access to data for repeated use and are one of the most essential infrastructures for many SSH fields. They provide the input for chronological and international comparisons; multiply the effects of the investments made for research; and play a key role in research methodology and organisation and the dissemination of scientific information. Accessibility to international databases containing Czech data is an important prerequisite for attaining excellence and participating in international cooperation. The users in the Czech Republic include researchers from universities, research organisations and the state administration. Data archives are also widely used for educational purposes.

ESS – Survey

The **ESS (European Social Survey)** is a long-term international programme focused on studying the key social indicators and the most important social science issues. It is specifically focused on creating a publicly accessible database that will be available to chronological and international comparisons. The extent of this database makes it possible to solve specific tasks that are very demanding with regard to data file size. The ESS is currently being implemented in thirty-six countries. This project has been awarded the prestigious Descartes Prize and it is one of the leading large ERA infrastructures, which has numerous applications across a range of SSH fields and is an important source of data for European comparative research studies. The users of this infrastructure comprise research workers and students from universities and research organisations and specialists from the ranks of state administration. It is also used by journalists in Europe and other parts of the

world. Czech users account for a major part of the overall user group. The programme is aimed at developing ESS-ERIC as a part of the ESFRI process. Special emphasis is placed on the continuity of the research and the most complete representation of the ERA countries that is possible. The Czech Republic has been represented in the ESS by the Institute of Sociology of the ASCR since 2002.

LINDAT/CLARIN

The LINDAT/CLARIN Linguistic Data Centre at the Faculty of Mathematics and Physics of Charles University in Prague is focused on generating annotated linguistic data, interlinking various resources, the distribution of this data, and the development and distribution of technologies for linguistic research as well as for research in other disciplines of humanities. The centre functions as the Czech "node" of the **Common Language Resources and Technology Infrastructure (CLARIN ERIC)**, an international large infrastructure for sharing linguistic data and technology. CLARIN ERIC was established within the ESFRI framework and is linked to the European META-NET technological network that is currently in the preparatory phase. This project is highly interdisciplinary, significantly linking linguistics with information technology, mathematical and other electro-technical research areas. LINDAT/CLARIN integrates existing linguistic infrastructures, resources and databases and continues to develop them, thus creating a national referential linguistic data resource, which is openly accessible and is linked to databases abroad. In addition, this project provides a technological environment and offers services associated with linguistic research that is built on proven expertise. This project has a broad range of potential for use in linguistics and other SSH fields, for example for the administration and creation of information systems (libraries and documentation centres), for the development of linguistic software applications, and for modernising the educational process (language teaching, linguistic technologies and data processing). The Institute of the Czech Language of the ASCR, the Masaryk University in Brno, and the University of West Bohemia in Pilsen are project partners. The activities of the LINDAT/CLARIN centre have already been launched.

SHARE

SHARE (Survey of Health, Ageing and Retirement in Europe) is a longitudinal multidisciplinary research study of persons over the age of fifty and their families. The research programme is focused on the economic, social, psychological, and health factors associated with ageing. The information that is obtained will be used for the purposes of interactive research throughout Europe. The main topics that are addressed include demographics and family; education; physical and mental health; healthcare and health risks; cognitive functions; employment and retirement; mutual assistance and finances within the family unit; housing; income and household consumption; property; social support; activities; the quality of life; life history; and expectations for the future. The end result consists of a unique database that is accessible to the public and which makes it possible to perform international and chronological comparisons and to solve specific research tasks. The data are extensively used within socioeconomic research and there is an overlap with medical research. They are used to a significant degree in applied research, where they serve to formulate measures associated with social security, the labour market, healthcare, and education. The SHARE project is one of the leading longitudinal programmes within the European Research Area. The research has been underway since 2004, with the Czech Republic's involvement dating back to 2006. It was with Czech participation that the distributed SHARE European Research Infrastructure Consortium (SHARE-ERIC) was established. The Czech node of this infrastructure consortium is under the auspices of the Economics Institute of the ASCR. This is the first research infrastructure project in the ERA, which, on the basis of a decision on the European Commission, became the first European Research Infrastructure Consortium.

ICNC

The ICNC (Institute of the Czech National Corpus) generates, maintains and analytically processes the most extensive general database of the Czech language and makes it accessible for research and educational activities. This data resource includes synchronous, diachronous and parallel level corpora (language databases), which map out contemporary Czech, together with its development and its functional and geographic variability, and also include translations between Czech and twenty other languages. This infrastructure provides a modern environment for accessing and analysing databases and is the main large infrastructure for Czech linguistic research. In addition, it can also be used in other SSH fields. Corpora are extensively used in language education and in applied research related to information systems, translating and interpretation, pedagogy, and software development. The creation of a corpus relies on the cooperative efforts of the many institutions that provide the data for it. The ICNC is involved in cooperative efforts at the international level. It is an existing infrastructure, which is operated by the Faculty of Arts of Charles University in Prague.

Table

Name of the large infrastructure	Brief description	Infrastructure type	Year of completion
BHCL	Bibliographic database	National	Existing
CESSDA	Common European system providing data services for the social sciences	Czech node under ESFRI	Existing
ESS – Survey	Collection of comparative data on basic social indicators, used for researching the interactions between institutions attitudes, opinions and behavioural models	Czech node under ESFRI	Existing
LINDAT-CLARIN	Open sharing of linguistic data and technology between research institutions, for use in the humanities and ongoing applied research	Czech node under ESFRI	Existing
SHARE	Ongoing research underway within the ERA, focusing on issues related to health, the ageing population and socioeconomic topics	Czech node under ESFRI	Existing
ICNC	Database of the Czech language	National	Existing

1.4 Promising Projects

Czech Infrastructure for Egyptology

This particular project deals with completing and developing the basic Czech resource that deal with research in the field of Egyptology, i.e. the study of archaeological sites in Egypt. This is a unique facility, which is of the utmost importance for the continuation of archaeological research and will help to guarantee the achievement of international excellence in this field. The project operations are guaranteed by the Czech Institute of Egyptology of the Charles University Faculty of Arts. The project is specifically aimed at improving the technical environment, including facilities for researchers, the equipment required to perform archaeological fieldwork, the processing of findings, the storage of archaeological artefacts, and software for documentation and digitalisation.

In order to provide a conceptual solution to the fragmentation that currently exists with regard to large infrastructures and to prevent the discontinuity of long-term activities in certain SSH fields, we are recommending the initiation and implementation of three projects. These proposals are aimed at ensuring the integration and systematic development of existing infrastructures in the CR and are based on an assessment of the social science infrastructures that are functioning in more advanced countries, such as Great Britain, Germany and the Netherlands.

Coordinated implementation of socioeconomic research activities

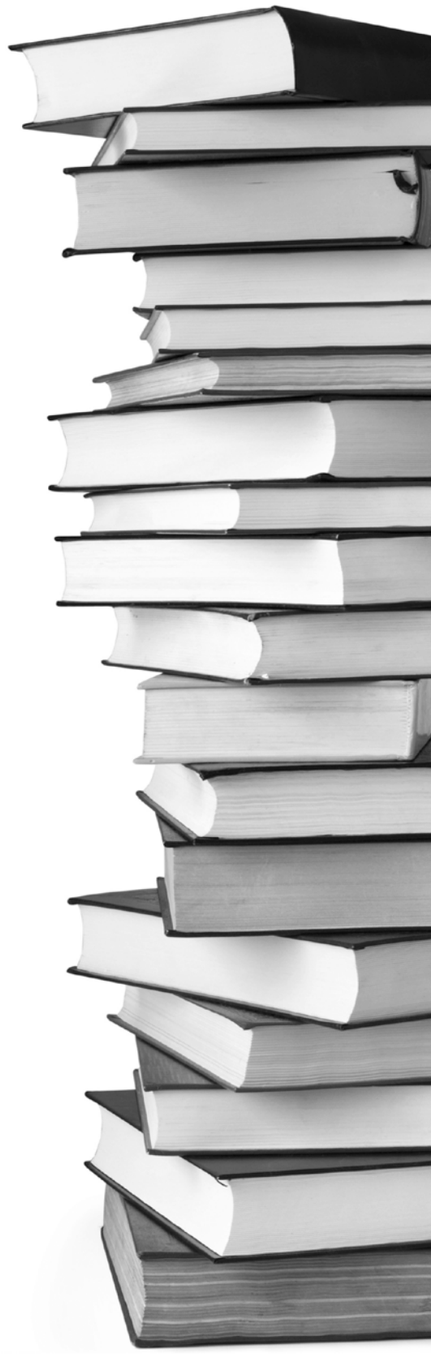
Long-term international research programmes are of great importance for the priorities defined for basic and applied research in the Czech Republic and also with regard to the CR's obligations towards the EU, the OECD and various international organisations. At the same time, they also create the data resources that are essential for a number of important research topics and the CR's participation is a prerequisite in order to ensure the country's inclusion in many international research projects. Specifically, they include international comparative research studies (e.g. the OECD's programmes focused on competitiveness and human resources, ongoing international projects, such the International Social Survey and the European Value Study, etc.) and the major national longitudinal programmes. As far as the Czech Republic is concerned, the research that falls within these programmes is generally performed in the form of short-term projects that are non-systematic and uncoordinated and subsequently have a negative impact on long-term objectives, quality and effectiveness. Research projects are performed by various institutions and are focused on more than one research area (e.g. the Institute for Information and Education, the Masaryk University Faculty of Social Studies, the Charles University Faculty of Art, the Institute of Sociology of the ASCR, CERGE-EI, the Charles University Faculty of Social Sciences, and others). These institutions might also be members of a consortium that has initiated a specific project. The thematic working group recommends that a project be initiated in order to integrate and develop existing activities. This project would interlink the institutes performing longitudinal research into a network (e.g. on the basis of the cooperation within a consortium). Furthermore, it would make it possible to coordinate activities and create an environment that would facilitate effective solutions within specifically focused programmes with clearly defined research priorities, a policy promoting open access to data, and involvement in international cooperation. An alternative is to join new integration activities within the ERA (e.g. the Gender and Generation Programme – GGP, the programme for Providing and Infrastructure for Research on Electoral Democracy in the European Union – PIREDEU, the Progress in Reading Literacy Study – PIRLS, and others).

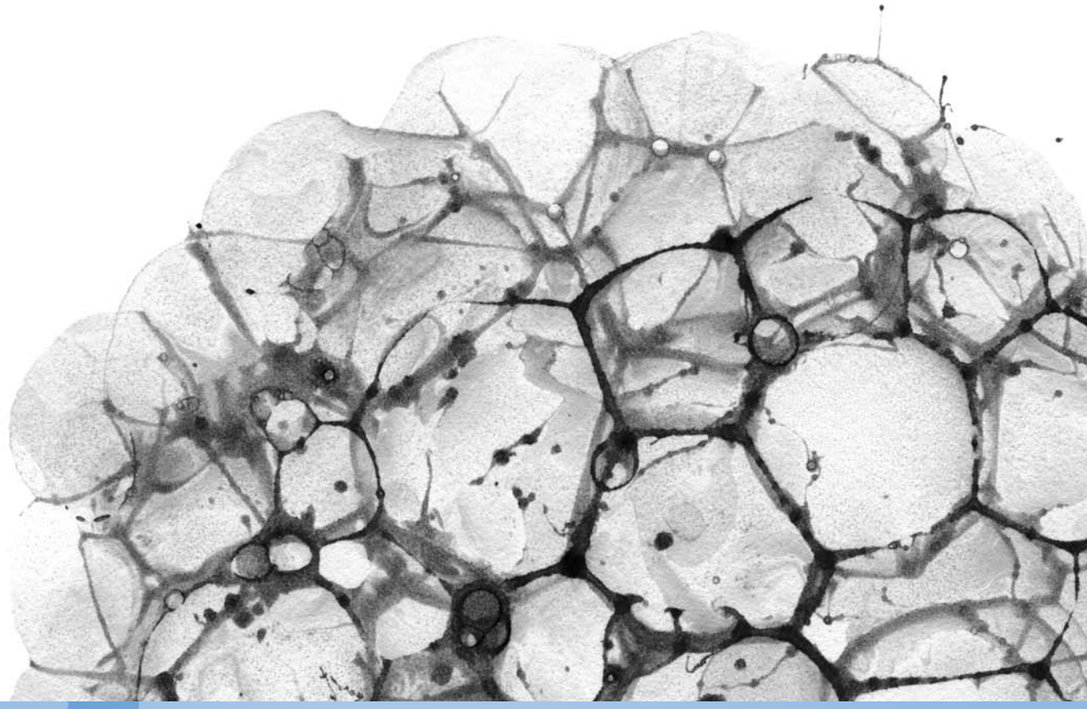
Digitalisation of and access to cultural heritage research materials

Many research organisations have extensive collections of cultural heritage materials, which they create and manage using their own internal systems in various technological environments and with different levels of access for external users. The sustainability of these resources is a prerequisite for the success of current and future research. Digitalisation and other new technologies make it possible to provide broad access to this data and to ensure its extensive use. We therefore recommend supporting a programme that would establish a distributed infrastructure, which will interconnect the relevant resources, support the digitalisation of research materials, develop a common information system, provide common access, facilitate the effective development and implementation of technologies, and incorporate these resources within the international systems in the ERA. The objective of this project complies with the ESFRI Digital Research Infrastructure for the Arts and Humanities (DARIAH) project, which does not yet have a Czech partner.

Bibliographic and information databases

Research organisations active in the SSH disciplines administer numerous bibliographic and information databases, which are quite often complementary. We recommend that support be provided to a project that would establish a common information system with uniform access and would coordinate the procedures for generating and maintaining these databases in order to facilitate and expand the use of these resources for research activities. Databases are essential for the research performed under the National Reference Framework for Excellence. Their interconnection would help to create an infrastructure that would complement similar system already operating within the ERA and would make it possible to intensify international cooperation.





Environmental Sciences (ENVI) 2

2.1 Current Status

The issues addressed within the environmental sciences (ENVI) have a long tradition in the Czech Republic, both in relation to the most current problems associated with environmental development and protection and the strategy for long-term sustainable development, as well as with regard to the expansion of the knowledge base that exists for the environmental sciences and the introduction of new methodological procedures (e.g. molecular ecology, remote sensing, e-databases, modelling, etc.). Recently, the sharing of data and databases has also started to be promoted.

Currently there are a large number of monitoring networks in the Czech Republic, which could be used as the foundation for developing a large research infrastructure within this particular field. However, there are great differences in the systems that are used and in the quality of operations. In addition, there are many operators and numerous sources of financing. As a result, the data is very fragmented and the ways in which these structures can be used is limited.

One very specific characteristic of the field of environmental sciences is the necessity for the long-term systematic and, most importantly, high-quality collection of data and its further processing, accumulation, and synthesis. If these processes are interrupted, if new observation sites are established in a non-systematic manner or if archived materials are lost, the resulting damage is irreparable. It is necessary to emphasise that within the field of environmental sciences short-term projects do not provide a guarantee of high-quality research. Ecosystem processes, the dynamics of change within ecosystems, and the consequences of changes to landscape use are all of a long-term nature, which does not promote high-quality research, and consequently the quality of research results, within the conventional system of providing grants. The Czech Republic's current obligations with regard to the environmental sciences require the implementation and completion of long-term research. Research structures that lack a conceptual structure, are not adequately prepared from the perspective of logistics and finish after only a short period of time cause irreparable damage. The long-term maintainability of a number of activities is essential for the success of current and future research in the environmental sciences and for the ability of this field to meet society's requirements for ecosystem services, including their sustainability.

The implementation of environmental science research projects that are only locally focused is no longer adequate. It is thus necessary to add on to the existing structures and to develop a single unique large infrastructure that is distributed throughout the Czech Republic and which will be open enough to provide an environment suitable for a range of fields. In order to do this, it is necessary to have available a high-quality e-infrastructure capable of effectively transferring data and with sufficient performance and storage capacity.

The need to develop modern research within the environmental sciences and to achieve interesting and real results meeting society's demands exceeds the abilities of individual institutions. As a result, it is of the utmost importance that this type of research be integrated within the European Research Area. It can be said that this integration is an essential condition that must be made, both for attaining excellence in the Czech republic as well as for successfully ensuring that the CR's national potential in the environmental sciences is included in international cooperative efforts.

Environmental research was originally a field of great breadth. Within the framework of the Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic it is now important to approach this particular field with a well thought-out selection of appropriate projects, which will gradually develop and merge into a single large infrastructure. This is the only way in which true excellence can be achieved, subsequently ensuring the CR's good position within the ERA. The primary object of the Czech Roadmap for supporting large infrastructures must consist of the long-term operation of an infrastructure that is unique in the field, that can be used intensively, and that has a strong link with international research.

The following paragraphs present an overview of the current status of Czech large infrastructures in the environmental sciences.

The Czech Republic currently has an existing **ecosystem monitoring station system** and studies are underway, which are focused on the impact that global climate change has on the Czech Republic's ecosystem carbon cycle. The ecosystem monitoring stations are involved in the ESFRI Roadmap **International Carbon Observation System (ICOS)** project. ICOS performs the long-term monitoring and quantification of the carbon flow (CO_2 is one of the major greenhouse gasses) in the CR's basic ecosystems (forests, grasslands, wetlands and cropland). The dynamics and magnitude of these carbon sinks are monitored in relation to predefined external environmental parameters through the long-term fumigation of forest growth with an increased concentration of CO_2 with the objective of charting the development of forest growth under conditions with an increasing CO_2 atmospheric content. The project administrator is the Global Change Research Centre of the ASCR (formerly the Institute of Systems Biology and Ecology of the ASCR). The Centre is also the Czech national coordinator for the ICOS infrastructure. **The Laboratory for Process Imaging and Remotes Sensing (RS**) is a system comprising a hyperspectral sensor and equipment for performing the process imaging of the ecosystem processes associated with the carbon cycle in the form of terrestrial, aerial and satellite images. The laboratory is a part of the European Fleet for Airborne Research (EUFAR) infrastructure. The Global Change Research Centre of the ASCR is in charge of this project. **The Czech Polar Stations in the Arctic and Antarctica** focus on the comprehensive geological and biological research of the Polar Regions. The stations are owned by Masaryk University in Brno and the University of South Bohemia in České Budějovice. The Czech National Centre for Polar Research was established in 2008 and brings together seven research institutions. The **Centre for Biodiversity Research** focuses on basic biodiversity research (flora and fauna) and on educating experts (education is provided at the Centre's partner institutions). The Centre is currently financed through a Ministry of Education, Youth and Sports project for Basic Research Centres, however a conceptual approach has not yet been prepared. The Global Change Research Centre of the ASCR is in charge of this project. There is a fragmented **monitoring network for seismic and geophysical phenomena occurring in the Czech Republic**. Its activities are financed through various sources and are carried out by several universities and the institutes operated by the Academy of Sciences of the CR. At this time, these monitoring stations are being integrated thanks to their involvement in the ESFRI Roadmap European Plate Observing System (EPOS) project. As a result, a project to establish an integrated CzechGEO/EPOS infrastructure, coordinated by the Institute of Geophysics of the Academy of Science of the CR is currently being prepared. The **Research Centre for Toxic Compounds in the Environment (RECETOX)** is operated by the Masaryk University in Brno and its laboratories are widely used by other organisations at the national and international levels. The Centre is a participant in the national MONET-CZ and GENASIS networks and the international European Monitoring and Educational Programme (EMEP), which acts as the coordinator for MONET EU and MONET Africa.

2.2 SWOT Analysis

Strengths:

- Extensive generation of data suitable for sharing;
- Involvement in prestigious international projects;
- A long tradition of summarisation and archiving activities; and
- Existing elements that can be used for establishing a large infrastructure.

Weaknesses:

- Long-term underfinancing;
- Low capacity levels; and
- Dispersion, fragmentation and the lack of coordination and a strategic approach.

Opportunities:

- Demands arising from the political will and compliance with the EU's priorities (ESFRI and FP7);
- Existing potential for transferring results to the application and innovation sectors;
- The openness of the Czech scientific community with regard to sharing resource materials;
- Opportunities for cooperation within international networks; and
- The realisation of high-priority policies, which provide support and promote education, regional development and applied research and which help to ensure the effectiveness of public investment in research.

Threats:

- An ongoing lack of sufficient financing;
- A lack of preparedness with regard to new EU programmes – a low level of awareness;
- A non-existent or inappropriate methodology used for evaluating infrastructures; and
- The incompatibility of local conditions with the obligations that exist in international networks.

Proposed Solution

As far as large infrastructures in the environmental sciences are concerned, a conceptual policy, based on society's needs and requirements, the CR's national research and development policy and the EU's priorities in this area must be implemented. It is necessary to emphasise the long-term nature of the research and the consequent operation and financing of large infrastructures.

At this time, the following high-priority topics have been identified within the national strategic framework for ENVI research:

1. Global climate change issues in their entirety, including biodiversity research and the overlaps that exist with regard to socioeconomic consequences;
2. Seismological and geological research; and
3. Environmental burdens – ecotoxicology.

2.3 High-Priority Projects

CzechCOS/ICOS

The CzechCOS/ICOS large infrastructure project is one of the projects headed by the Czech National Global Change Research Centre, which is the Czech node of the pan-European ICOS, EUFAR and LIFEWATCH large infrastructures. The CzechCOS/ICOS infrastructure will establish an environment for observation research at the level of the individual ecosystem types that exist in the Czech Republic. It will operate process imaging laboratories, including a domain specifically focused on biodiversity research, and will also provide a platform for the implementation of large biodiversity infrastructures. CzechCOS will include methodological tools that will make it possible to collect and process information about energy and substance flows, to perform biodiversity research, and to use image processing applications. CzechCOS has been designed as a centre of excellence, concentrating the efforts of a large part of the national expert potential in the field of global climate change and including the direct participation of experts from abroad (as members of the implementation team) and partnerships with leading international institutions in the field, which will also be directly involved in the final project solution. The concentration of knowledge potential that will result from this ENVI project will find further use during the strategic decision-making procedure and for supporting technologies that are focused on alleviating the impact of global climate change and adapting to the consequences of global climate change. The national CzechCOS/ICOS infrastructure has a direct connection to and is interlinked with the RDI OP Priority Axis 1 project "CzechGlobe – Centre of Global Impact Change Studies", which is being implemented through the Global Change Research Centre of the ASCR. The CzechCOS project is an appropriate complement, in particular with regard to ecosystem research.

CzechPolar

The Czech Polar project associated with the Czech polar stations in the Arctic and Antarctica, should eliminate the existing fragmentation of activities. It will interlink the activities of both stations and will provide access to a large infrastructure that can be used by researchers throughout the Czech Republic. with The main objective of the research in Antarctica, which is carried out by the J. G Mendel Polar Station situated on James Ross Island, is to perform a comprehensive investigation of the relatively young ice-free Antarctic coastal area, referred to as the Antarctic Oasis, which is one of the very few areas in the region that allows the existence of life. The project includes research in the disciplines of geology, physiogeography and biology. This comprehensive research aims to identify the structure, development and functioning of the Oasis in terms of the mutual influences of its abiotic and biotic components, to prepare a prognosis for its future development, and to generate a model of the possible changes that may result due to climate change. The second Czech polar station is located in the Arctic Region on the Svalbard Archipelago. There are plans to establish a base at this location. At this time negotiations are underway with the Norwegian Ministry of Education and Research. The Czech side of this project intends to announce the location selected for this base in June 2011. The aim of this currently ongoing project is to study the biological and climatic diversity of the area and to define the relationships that exist between the diversity/productivity and the environmental climatic/macroclimatic factors. Thanks to the better accessibility that it provides, the Northern Polar Station can be used to provide training and education for students involved in all of the fields associated with polar climate conditions.

The Czech National Centre for Polar Research (NCPR) was established in 2008 and brings together the following seven institutions, which all participate in integrated polar research activities and share the relevant infrastructures: the Masaryk University in Brno, the University of South Bohemia in České Budějovice, the Czech Geological Survey, three institutes of the ASCR (the Institute of Botany, the Institute of Geology and the Biology Centre), and Comenium o.p.s. (an NGO). The members of the NCPR work together with a number of foreign institutions (the Argentine Antarctic Institute, the Chilean Antarctic Institute, the British Antarctic Survey, Servicio Meteorológico Nacional Argentina [Argentina's national weather ser-

vice], and the Netherlands Institute of Ecology). They are also members of international groups (the European Polar Board under the European Science Foundation, the 2007–08 European Polar Consortium, and the Committee for Environmental Protection under the Antarctic Treaty). The Czech government approved the CzechPOLAR project in March 2010.

CzechGEO/EPOS

The fragmentation of activities that exists in the field of geophysics should be remedied thanks to the CzechGEO/EPOS project, which will establish permanent seismic stations under the integrated Network for Monitoring Seismic and Geophysical Phenomena. The resulting integrated infrastructure will represent the Czech part of the pan-European EPOS project for monitoring geophysical phenomena and will have a worldwide outreach. The permanent seismic stations located in the Czech Republic will monitor earthquakes and other seismic phenomena in Central European as well as at other locations around the world. The seismologic data centres of the Institute of Geophysics of the ASCR in Prague and the Institute of Physics of the Earth in Brno are responsible for collecting and archiving the data from the seismic observatories, interpreting seismic signals, preparing bulletins and catalogues of earthquakes, and ensuring the international exchange of digital data, and the parameters of the seismic phenomena that are recorded. As part of an extensive international cooperative effort, the Czech network contributes data to the ORFEUS European-wide seismologic centre in the Netherlands, to the worldwide data centre in Seattle, and to several European national centres. It also participates in the prompt localisation of earthquake occurring anywhere in the world and is involved in a number of European earth science programmes. The following institutes are involved in this project in the Czech Republic, specifically the Institute of Geophysics of the ASCR (which acts as the national coordinator), the Institute of Rock Structure and Mechanics of the ASCR, the Institute of Geonics of the ASCR, the Charles University in Prague, the Masaryk University in Brno, and the Research Institute of Geodesy, Topography and Cartography.

RECETOX – Research Centre for Toxic Compounds in the Environment (CETOCOEN)

The Research Centre for Environmental Chemistry and Ecotoxicology (RECETOX), established in 1996 at the Masaryk University in Brno using financing from the PHARE European project, provides the base for this project. From the very start, the Centre has been involved in international networks and projects. ITs objectives have been focused on monitoring and assessing the transport of atmospheric pollutants in Europe. The European Monitoring and Evaluation Programme (EMEP) network of monitoring stations was established to support the international Convention on Long-Range Transboundary Air Pollution as one of the most important means of air protection in Europe. The National Centre for Persistent Organic Pollutants was established as the main workplace, specifically as a scientific research base specialising in the chemical and toxicology research of twenty-two substances that are the subject of international treaties and agreements that the Czech Republic has signed. The Centre is in the process of preparing its infrastructure for developing and expanding scientific capacity in the fields of environmental chemistry, ecotoxicology and risk assessment in the developing regions. It organises training courses, summer educational programmes, workshops, and conferences. The original network in the Czech Republic gained a reputation as a very successful model for establishing similar programmes in other countries and regions. The Centre is planning the construction of new facilities, which will provide state-of-the-art equipment for trace analysis laboratories, laboratories for studying environmental processes, laser facilities for studying photochemical reaction mechanisms, ecotoxology laboratories that will make it possible to monitor the effects of toxic compounds on organisms down to the molecular level, training laboratories, and lecture halls. On the one side, the infrastructure will provide an environment facilitating scientific research associated with the environment and sustainable development. On the other, it will establish a platform to be used for developing new methods, ways of transferring technology and know-how, and consultancy and educational activities. RECETOX is directly linked to the project for establishing the Research Centre for Toxic Compounds in the Environment (CETOCOEN project) that was been approved under Priority Axis 2 of the RDI OP and will be implemented by Masaryk University.

The RECETOX project is involved in several international programmes, including EMEP (European Monitoring and Evaluation Programme), a collaborative project focused on monitoring and assessing the transport of atmospheric pollutants in Europe; the WMO (World Meteorological Organisation); GAW (Global Atmosphere Watch); ICP-IM (International Cooperative Programme on Integrated Monitoring); ACCENT (Atmospheric Composition Change – The European Network of Excellence); and EUSAAR (European Supersites for Atmospheric Aerosol Research).

The infrastructure of the Trace Analysis Laboratories includes equipment that facilitates the monitoring of organic and inorganic pollutants within all environmental matrices using, in particular, chromatographic separation and mass spectroscopy methods, including high-resolution fraction collectors. The Environmental Chemistry and Modelling Division operates laboratories specialising in the research of transport and transformation processes in the environment, i.e. factors such as vaporisation, absorption, bioaccessibility, accumulation, and ecological balances. The Ecotoxicology and Risk Assessment Division operates ecotoxological laboratories equipped for all types of ecotoxological and biological experiments.

Table

Name of the large infrastructure	Brief description	Infrastructure type	Year of completion
CzechCOS/ICOS	Monitoring system for energy and substance flows, process imaging, and biodiversity development under the impact of global climate change	Czech node of the ICOS, EUFAR and LIFEWATCH projects	Existing
CzechPolar	Operation of the J. G. Mendel Station in Antarctica and the development of polar research in the Arctic	National	Existing
CzechGeo/EPOS	Established network of seismic stations, involved in the long-term measurement of seismic activities and phenomena	Czech node of the EPOS project	2015 – foundations are in place
RECETOX	Established infrastructure of laboratories	National	Existing

2.4 Promising Projects

Laboratory for Isotope Geochemistry and Biogeochemistry – LIGAB

Modern approaches to studying the biogeochemical processes in soil and other ecosystems and the processes associated with human health and activities are dominated by approaches based on the application of (i) stable isotopes; (ii) radiogenic and non-traditional isotopes; and (iii) natural and technogenic gamma-active isotopes. Mass spectrometers, which make it possible to identify the occurrence of individual isotopes, have been in existence and developing for over ninety years. They vary in construction and, as a result of the broad range of systems that are studied, ranging from hydrogen to uranium, particularly in the way that samples are loaded into the mass separator.

The project for expanding the Charles University in Prague Albert Campus presents an opportunity to prepare an ideal environment for these complex and highly-sensitive instruments, i.e. an environment that is ultrapure and equipped with appropriate networks, protection against various disruptive influences, and with an appropriate configuration of individual workplaces and laboratories. This could lead to the establishment of a unique national complex for isotopic research that could ultimately extend into the surrounding Central European region. The proposed infrastructure is unparalleled in the Czech Republic and consists of a complementing set of equipment and laboratories for performing mass and gamma spectrometry, for which the project proposer would provide the space and human resources. It can be roughly separated into the following three areas of interest:

(1) Stable isotopes H/D, $^{18}O/^{16}O$, $^{34}S/^{32}S$, $^{13}C/^{12}C$, $^{15}N/^{14}N$, $^{28}Si/^{29}Si$

(2) Radiogenic and non-traditional isotopes; and

(3) Technogenic and natural gamma-active radionuclides.

The infrastructure includes a gamma spectrometric laboratory for measuring and studying the natural radionuclides 226 Ra, 238 U and 232 Th as well as the gamma-active radionuclides 137 Cs, 241 Am a 239 Pu. The identification of these isotopes will assist in assessing the level of radionuclide contamination in the environment. It will also facilitate the performance of other activities, such as the accurate dating of the processes that take place at the boundaries of the earth's crust, hydrosphere and atmosphere. The isotopic systems mentioned above are used by laboratories active in the fields of chemistry, ecology, hydrogeology, archaeology, dendrology, climatology and oceanology, which perform research associated with the climate, geochemistry and biogeochemistry, resource geology, materials, physiology, hydrology, hydrogeology, and the environmental sciences.

National SoWa (Soil and Water) Infrastructure for the complex monitoring of the soil and water ecosystems within the context of permanently sustainable landscape use

This infrastructure is built on the expert environment that has been systematically developed over more than the past ten years. This infrastructure, which is not yet complete, made it possible for the employees of the Biology Centre of the ASCR in České Budějovice to attain international renown in the field of researching ecosystems with various degrees of anthropogenic contamination (commercial forests, agroecosystems, urban ecosystems and polluted waters) and in extreme locations (caves, deserts, semideserts, soils exposed due to glacial retreat, and geological layers located more than 100 metres below the surface of the earth). Thanks to the partial SOWA infrastructure that already exists, the Biology Centre is involved in international cooperative projects at this time.

The infrastructure will facilitate the monitoring of the functions of soil and water ecosystems using key ecosystem parameters through:

- Measuring the basic abiotic and biotic indicators of water and soil quality;
- Measuring the nutrient and energy cycle and preparing models of ecosystem productivity under changing environmental conditions; and
- Performing the various measurements required in order to recommend measures to repair the damage caused by human activities.

The laboratories are methodologically specialised to study the following areas:

Biodiversity: specifically the identification of organisms using microscopic and molecular biology methods and the monitoring the dynamics of the societies of these organisms in relation to the processes that lead to the creation of these societies in soil and water ecosystems. Studying biodiversity is of key importance for understanding the roles played by the individual components of an ecosystem within its overall function and for estimating the threshold values for acceptable burden in the use of these ecosystems.

Nutrient lifecycle: specifically the monitoring of nutrient flows within an ecosystem and between ecosystems as supporting information for the rational use of ecosystems and for the purpose of implementing corrective measures to remove any damage that does occur. The Czech Republic faces a significant problem with soil and water pollution resulting from the influx of nutrients from point sources (e.g. urban areas and industrial companies) and area sources (e.g. agriculture and aquaculture). The infrastructure will make it possible to accurately identify the causes of the pollution and to monitor the effectiveness of corrective measures.

Monitoring a modelling: specifically the use of automated stations for collecting primary data in model ecosystems and the computerised extrapolation of this data and its application to large territorial areas. The laboratories will assign teams to monitoring changes in the landscape with the goal of preventing serious damage as a result of human activities and to be prepared for natural changes, such as global warming. The collection of data from biotopes monitored over the long-term will make it possible to define algorithms that show the trends in biotope development and possible changes to the entire landscape.

Production ecology: specifically the measurement of the primary and secondary production of soil ecosystems (e.g. calorimetry and analysis of gases, including greenhouse gases) and water ecosystems (e.g. the monitoring of respiration and other parameters). In the case of water ecosystems, the measurement of production includes the production at the highest trophic levels – the size and composition of fish stock using a unique pan-European system of hydroacoustic and capturing methods and resources.

3 Material Physics and Space

3.1 Current Status

Current material physics research requires extensive technical facilities that facilitate the preparation of various forms of top-quality experimental samples, ranging from thin layers, multilayers and nanoparticles to large defect-free monocrystals, equipment that guarantees the reliable characterisation of structure and composition, and instruments that are capable of measuring adequate sets of material parameters using complementary macroscopic and microscopic measurement techniques. The development and operations of certain unique facilities and equipment is so demanding that it can be effectively used only through the creation of large infrastructures, which serve the wider scientific community. The text below specifies existing laboratories in the Czech Republic that meet the criteria for a large infrastructure as well as facilities that have international status and are used by the Czech scientific community.

As far as basic research on the interaction between radiation and materials is concerned, one such facility is the **PALS Research Centre**, operated jointly by the Institute of Plasma Physics of the ASCR (IPP ASCR) and the Institute of Physics of the ASCR (IP ASCR), which has been used as a large infrastructure by Czech and European scientific institutions throughout Europe since 2000. PALS is a first-class facility involved in the research and application of laser plasma, the interaction between radiation and matter, and X-ray lasers. It plays a major role in the development of laser-generated high-energy ion beams with energies up to several MeV/nucleon. Amongst other activities, these facilities perform research associated with the properties of materials under conditions of extreme temperatures and pressures and are involved in unique research and application projects dealing with the modification of surfaces. The planned construction of the **Extreme Light Infrastructure (ELI)** as a part of the ESFRI programmes will help the Czech Republic to achieve excellence in this field of research that deals with the highest currently attainable energies. The ELI laser is a large ESFRI infrastructure, which will be located in the Czech Republic. It will generate electromagnetic radiation (light) with extreme properties and with a radiation intensity exceeding the levels that are currently available around the world many times over. ELI will be a multi-purpose facility used primarily for basic research associated with the interaction of radiation with matter in the ultra-relativistic regime, for materials testing, for the development of new medical diagnostic methods and advanced radiotherapy methods, and for verifying new methods of obtaining energy from nuclear fusion using inertial confinement lasers. Another important supporting project is **HiLase**. The main goal of this project is to develop new laser technology with breakthrough technical parameters and a high repetition frequency for use by industry and in research. The project was submitted by the IP ASCR within the framework of Priority Axis 1 – Regional research and development Centres under the Research and Development for Innovation Operational Programme. It was recommended for financing and is currently in the last phase of successful negotiations.

Material research in the field of nanotechnology is currently carried out in the Czech Republic primarily by the **Laboratory for Nano-Structured Materials (LNSM)**, operated by the IP AVCR, which consists of two main parts – a laboratory for semiconductor nanostructures and a laboratory for bulk nanomaterials. On the other hand, a broad range of measurements of physical material parameters under multi-extreme conditions (low temperatures, strong magnetic fields and high pressures) are offered by the **Magnetism and Low Temperature Laboratories (MLTL)**, which are operated by the Charles University Faculty of Mathematics and Physics in cooperation with IP ASCR. In addition the MLTL make it possible for Czech scientists to access magnetism laboratories located abroad, which are equipped with strong magnetic fields (stronger than 14 T, which is the maximum level currently attainable at the MLTL). In addition, the Charles University Faculty of Mathematics and Physics, once again acting in cooperation with the IP ASCR, operates the **Materials Science Beamline at the ELETTRA Synchrotron in Trieste**, thus ensuring the availability of unique experimental facilities to the Czech scientific community for studying photo-emission spectroscopy at one of Europe's best synchrotrons.

Experimental opportunities based on methods using the interaction of neutrons and ions with materials at a microstructure level are offered by the **CANAM Centre for the Modification and Analysis of Materials with Ions and Neutrons**, which is operated by the Nuclear Physics Institute of the ASCR along with its accelerators and other equipment built on the LVR-15 reactor platform. The U-120M cyclotron is used for the study of nuclear reactions and for the preparation of radionuclides for the research, development and commercial production of radiopharmaceuticals. It is also a unique source of fast neutrons. The Tandetron 4130MC electrostatic accelerator is used for performing material analysis using ion beams and the modification of materials using ion implantation. The experimental equipment installed on the neutron radiation channels of the LVR-15 reactor (Řež Nuclear Research Institute) are intended to be used for performing the structural and elementary analysis of materials using neutrons.

The **Van de Graaff – HV2500 Proton Accelerator** resolves the urgent need for an adjustable monochromatic neutron source for projects focused on neutron physics. Preparations are underway to modify the HV2500 accelerator to be an "ESA approved neutron facility", which can be used for testing space research equipment with regard to its resistance against neutron and space radiation.

The Czech scientific community's direct access to unique experimental apparatuses in large international laboratories is of key importance for ensuring the excellence of Czech physical materials research. The Czech Republic has been a member of **CERN** – the world's leading centre for the study of the fundamental properties of mass – since its inception and is actively involved in its activities, not only by participating in experiments, such as **ATLAS** and **ALICE** to name but two, but also on the basis of orders it receives for supplying unique equipment. Participation in the D0 experiment using the **Tevatron** at the Fermilab facilities in the USA, and in the experiments performed at the **Pierre Auger Observatory** in Argentina (the study of the ultra-high energy cosmic showers) and at the **LSM/JOULE** facility in France (neutrino physics) is important for the Czech Republic's advancement in the field of particle physics. One of the most important research institutions focused on basic and focused research in heavy ion physics is the **GSI Helmholtz Centre for Heavy Ion Research**. Cooperation with GSI makes it possible to participate in experiments focused on studying nuclear matter under extreme conditions.

The Czech Republic's scientific membership in the **Max von Laue and Paula Langevin Institute (ILL)** in Grenoble provides excellent opportunities for participating in experiments using the strongest stationary neutron source in the world. The country's membership in the **European Synchrotron Radiation Facility (ESRF)**, also located in Grenoble, offers extensive possibilities for performing experiments using one of the strongest existing sources of synchrotron radiation. Both the ILL and the ERSF are in the process of completing programmes to upgrade their facilities (the **ILL 20/20 and ESRF Upgrade Programmes**), which will greatly improve the quality of a broad range of experimental apparatuses and will make it possible to perform experiments that are not possible at this time. The Czech scientific community will be an important participant in the **ThALES** project under the ILL 20/20 programme in the form of an in-kind contribution aimed at constructing a next-generation three axis spectrometer for studying low-energy inelastic neutron scattering. The Charles University Faculty of Mathematics and Physics is the project co-ordinator.

The development of excellent Czech material physics research requires the Czech Republic's participation in the large international infrastructures currently under construction, such as the European Spallation Source (**ESS**) in Lund, Sweden, which is involved in neutron utilisation research, and the X-ray Free Electron Laser (**XFEL**) in Hamburg, Germany, which is focused on the study of intense X-ray radiation. The involvement of Czech scientists in these infrastructures, which is currently in the early preparation phase, will ensure that the Czech Republic has an equal position within the international community and will lead to invaluable results from the very start of operations at the infrastructures. The Czech Republic is also one of the sixteen partner countries officially accepted to participate in the ESS project.

From the long-term perspective, the Czech scientific community's significant participation in the facilities newly planned under ESFRI – SPIRAL2 and FAIR (Facility for Antiproton and Ion Research) – will be of the utmost importance. The **SPIRAL2** facility, situated at the French GANIL laboratory, will ensure worldwide competitiveness as early as in 2015, at which time

it is scheduled to meet the planned specifications. The facility will produce primarily radioactive beams (although intense stable ion beams will be produced as well) using the Isotope Separation On-Line (ISOL) technique. SPIRAL2 is included on the ESFRI list of large European infrastructures. **FAIR** will make to possible to perform unique experiments with antiproton and heavy ion beams. This new European research centre in Darmstadt, Germany, includes an accelerator system, which will generate beams of protons, antiprotons, heavy ions, and exotic radionuclides with energy levels of up to 35 GeV for use in experiments. These energy levels greatly exceed the levels that can be currently attained and will thus make it possible to study physical processes under extreme conditions that are inaccessible at this time.

At this time, the Czech Republic's most important partner in the field of astronomy research is the **European Southern Observatory (ESO)**, an intergovernmental European organisation for space research established in 1962. The Czech Republic joined ESO in 2007 and is one of the organisation's fifteen members. The main objectives of this organisation are: to perform astronomy research from the earth's surface using cutting-edge technologies; to collaborate with facilities and apparatuses located in space; and to participate in educational programmes in the natural sciences and in awareness-raising programmes that involve the general public. The Czech Republic's membership in ESO ensures access to projects that use the telescopes of the La Silla and Paranal Observatories in Chile. In the future, the ALMA (Atacama Large Millimeter/submillimeter Array) interferometer and the European Extra Large Telescope (E-ELT), which is an ESFRI project, will also be accessible. In order to support the ability to take advantage of these possibilities, the Astronomical Institute of the ASCR established the **Centre for Cooperation with ESO and ESA** and a regional node for the ALMA interferometer.

The **European Space Agency (ESA)** is an international intergovernmental organisation supporting the development of space research and space technologies. It was established by the ESA Convention of 30 May 1975. The Czech Republic became the eighteenth official ESA member in 2008. In addition to its headquarters in Paris, the ESA includes the **Centre Spatial Guyanais (CSG)** spaceport near Kourou in French Guiana, the Columbus Module on the International **Space Station (ISS)** and five research centres. The **European Space Research and Technology Centre (ESTEC)** is the largest ESA research centre and is located in Noordwijk in the Netherlands. This centre specialises in technical research and development in the field of space physics and astronomy, microgravitation, telecommunications, and earth observation. The **European Space Operations Centre (ESOC)** in Darmstadt, Germany, is responsible for the performance of apparatuses in orbit. It controls the operations of artificial satellites and planetary probes, and it also receives and processes the data from various experiments performed by the European Columbus Module on the ISS. The **European Space Research Institute (ESRIN)** is situated in Frascati, Italy. ESRIN specialises in the issues associated with obtaining, processing and distributing the data received from satellites used for earth observation. Cologne on the Rhine, Germany, hosts the **European Astronauts Centre (EAC)**, which organises the training for European astronauts and ensures their preparation for specific flights. The **European Space Astronomy Centre (ESAC)** is located in Spain and concentrates on astronomy research using space probes and satellites.

3.2 SWOT Analysis

Strengths

- Scientific excellence and important scientific results;
- The uniqueness associated with participation in international infrastructures, such as CERN, TEVATRON, ESRF, ELETTRA, ESS, ILL, ThALES, MLTL, LNSM, PALS, ESO, ESA, and others;
- Cooperation between infrastructures, including, amongst other things, methodological complementarity and synergy during research associated with new materials, such as the macroscopic methods used by the MLTL, the microscopic methods used by ESRF, ELETTRA, ILL, and ThALES, the preparation and characterisation of new biological materials (EMBL) and the microscopic study of this data (ESRF and ILL Grenoble);
- The extensive experience of Czech facilities;
- The international acknowledgement of Czech facilities, such as LASERLAB EUROPE and NMI3-ACCESS to name but two;
- The recent construction or innovation that has been completed, such as the completion of PALS, the purchase of a new Tandetron accelerator, the ongoing innovation of experimental facilities using the LVR-15 reactor, the MLTL, etc.;
- World-class Astrophysical research;
- Involvement in top projects; and
- The ability to obtain industrial contract during the construction of the ALMA and E-ELT facilities.

Weaknesses

- Lack of sufficient finances for the operation and upgrade of some equipment and facilities poses a threat to the permanent sustainability and development of certain infrastructures;
- The age of certain equipment (such as the U-120M Cyclotron installed in 1977) and its replacement with more powerful and modern equipment would significantly expand the existing experimental capacity;
- The current methods of financing the operation of infrastructures, in particular required repairs and maintenance, which must be paid from randomly obtained resources (e.g. grants and one-off financial assistance);
- The share of financing received from the private sector is minimal in the Czech Republic, primarily due to the non-existence of appropriate motivational mechanisms;
- Neutron experiments are carried out using the LVR-15 reactor operated by the Řež Nuclear Research Institute and the financing for the operations of this reactor presents an ongoing problem; and
- A small number of companies capable of implementing technologically demanding contracts.

Opportunities

- Education for students and training for young scientists;
- Great interest in experiments performed at national and foreign facilities;
- Long-term cooperation with established partners in the Czech Republic and abroad, which will continue in the future;
- New opportunities for cooperation arising as a result of the development of new facilities (e.g. ELI, HiPER, CEITEC, ESO, the completion of laboratories, etc.);
- The development of nanotechnologies, new materials and structures with intelligent surfaces and exceptional mechanical, electrical, magnetic, optical and biological properties;
- The training and education of a new generation of scientists, who are capable of implementing the ESO's astrophysical projects; and
- The development of companies capable of implementing technologically demanding contracts.

Threats

- The undervaluation of the need for the Czech Republic to be involved in important European infrastructures at the time they are planned and built (for example, ESS, XFEL, SPIRAL2, and FAIR); and
- The lack of suitable young people, who could be trained to continue with the scientific work carried out at large and demanding infrastructures once they are completed (for example, ELI).

Proposed Solution:

- A focused effort on increasing awareness about the European infrastructures both within the scientific community as well as on the part of the state authorities, and the preparation of an impact analysis on the Czech Republic's involvement (or lack of involvement) in these infrastructures;
- Specifically focused work with lower level university students in order to recruit them for scientific work;
- Motivational programmes for young scientists;
- Special programmes for Czech scientists returning from abroad; and
- Support for creating the conditions to attract foreign scientists.

3.3 High-Priority Projects

Existing infrastructures and projects of pan-European significance – the highest priority

a Infrastructures in the Czech Republic

ELI

The **ELI (Extreme Light Infrastructure)** laser is a larger ESFRI infrastructure, which was approved by the European Commission on 20 April 2011 to receive financing from the Structural Funds allocated for the Czech Republic. The Czech Republic will be the site of the ELI-Beamlines infrastructure, which will produce ultra-high intensity electromagnetic radiation that is many times higher than the existing record attained by the British ASTRA laser. It will be used as a multi-purpose facility, primarily for basic research associated with the interaction of radiation with mass in the ultra-relativistic regime, for materials testing, for the development of new medical diagnostic methods and advanced radiotherapy methods, and for verifying new methods for obtaining energy through nuclear fusion using inertial confinement lasers. The results from the experiments performed using the ELI laser will lead to a new generation of compact particle accelerators (electron, proton and ion) and will be used for developing, for example, a table-top X-ray free-electron laser. The intention to construct ELI in the Czech Republic is supported by Decree of the Czech Government No. 1514 of 24 November 2008. The ELI-CZ Consortium, which brings together a total fourteen research institutions of the ASCR and various universities, is also involved in the preparatory tasks for constructing ELI. The main partnering countries for the preparatory phase of the ELI project are Hungary, Romania, Germany, France, and Great Britain.

PALS

The **Prague Asterix Laser System (PALS) Research Centre** is a laser laboratory jointly operated by the Institute of Plasma Physics of the ASCR and the Institute of Physics of the ASCR. The PALS facility itself is administered by the Institute of Plasma Physics. PALS is a founding member of the LASERLAB-EUROPE Consortium and is also involved in the inertial fusion research coordinated by EURATOM. The PALS laser is a terawatt pulsed iodine photodissociation laser and it is one of Europe's most powerful lasers. The intensity of the focused beam on the target reaches several tens of petawatts per square centimeter. The main laser is supplemented with a plasma X-ray zinc laser developed in the PALS laboratory, which attains world record parameters and operates at a wavelength of 21.2 nm. The laser can be used for a broad multidisciplinary range, including plasma physics, radiation physics and chemistry, thermonuclear and materials research, and laboratory astrophysics. The laser and the laser plasma can also be used in biology and for medical purposes. The institutions that collaborate with PALS at the national level include the other institutes of the ASCR, the Faculty of Nuclear Sciences and Physical Engineering and the Faculty of Electrical Engineering of the Czech Technical University in Prague. At the international level, they primarily include the members of the LASERLAB-EUROPE Consortium: the Rutherford Appleton Laboratory; LULI – Laboratoire pour l'Utilisation des Lasers Intenses; Frascati ICF Laboratory; DENIM - Polytechnic University of Madrid; the Institute of Plasma Physics and Laser Microfusion in Warsaw; the Institute of Optoelectronics of the Military University of Technology in Warsaw; the University of York; Deutsches Elektronen- Synchrotron DESY; the Lawrence Livermore National Laboratory, and others.

MLTL

The **Magnetism and Low Temperature Laboratories (MLTL)** located on the premises of the Charles University Faculty of Mathematics and Physics (CU FMP) in Prague's Troja District operate a system of unique cryogenic and cryomagnetic apparatuses supplied with liquid helium from a local liquefier, which also supplies other local university and academic laboratories in Prague and the immediate surroundings. The MLTL apparatuses Aparatury provide students and other users in the Czech Republic and from abroad the opportunity to obtain high-precision and effective measurements of various properties of materials under multi-extreme conditions (combinations of temperatures ranging from 30 mK to 1000 K, strong magnetic fields of up to 14 T, and high pressure of up to 26 GPa), which are required for modern materials research and the comprehensive study of superfluidity and quantum turbulence. The laboratories were established in 1998 on the basis of an agreement between the Charles University Faculty of Mathematics and Physics and the Institute of Physics of the ASCR. They are administered by the CU FMP. The MLTL also make it possible to prepare and characterise high-quality samples of new materials.

LNSM

The Laboratory for Nano-Structured Materials (LNSM) is owned by the IP AVCR and consists of two parts.

– The first is the Centre for the Preparation of Semiconductor Nanostructures and it is one of the key facilities included in the Ministry of Education, Youth and Sports LC510 project for a Research Centre for Nanotechnologies and Materials for Nanoelectronics. It also receives support from, amongst other sources, the Seventh Framework Programme. The LNSM makes it possible to prepare semiconductor layers with atomic resolution, and to build microchips measuring only a few tens of nanometres using these layers and electronic elements. The Centre has all of the required equipment for performing experimental studies of quantum-relativistic phenomena in the field of solid-state physics and for studying the properties of microelectronic components that are smaller than 100 nanometres in size. The Centre has two units: a facility for performing molecular beam epitaxy (making it possible to prepare thin-layer monocrystalline materials from molecule beams using epitaxy methods), and a facility for performing the lithographic structuring of thin-layer materials (making it possible to prepare lateral microstructures and nanostructures).

– The second is the Centre for Bulk Nanomaterials, which is supported under a project included in the Nanotechnologies for Society programme, is focused on the technologies involved in the preparation of metal materials with an ultrafine-grained/nanocrystalline structure, the characterisation of these materials, and the study of their important physical and chemical properties. In addition to new equipment for performing mechanical tests under temperatures ranging from -150ºC to 1100ºC and several moulds for preparing materials with an ultrafine structure using severe plastic deformation (specifically the ECAP method), the most important equipment operated by the Centre is the fully-equipped double beam microscope (electron and ion), including the required infrastructure. Next year the laboratory will acquire a state-of-the-art analytical transmission electron microscope (TEM) for studying subnanometer structures.

SAFMAT

The **SAFMAT Centre for the Analysis of Functional Materials** is a project of the Institute of Physics of the ASCR, which was approved for financing during the second call for projects under the Prague Competitiveness Operational Programme. The type of research facilitated deals with the analysis of new materials from the perspective of their atomic composition and structure. The research performed under the SAFMAT project also involves the metrology of thin layers in the field of nanotechnology. SAFMAT is also focused on the

analysis of technologically important centres and the defects responsible for the localisation of the electric charge in semiconductor, magnetic and other types of materials. SAFMAT will be equipped with two of the most modern instruments available for the characterisation of functional nanostructured materials. The first is NanoESCA, an apparatus that uniquely combines photoelectron microscopy with electron spectroscopy for studying chemical composition and structural properties using nanometric spatial resolution. The second is an EPR Spectrometer, which can determine the structure, dynamics and spatial distribution of particles at the atomic level in any type of materials at temperatures ranging from 4 to 300 K. In addition to solid materials, this instrument is also capable of analysing gels, liquids, and biological samples.

CANAM

The **CANAM Centre of Accelerators and Nuclear Analytical Methods**, located in Řež (near Prague), is operated the Institute of Nuclear Physics of the ASCR and is equipped with particle accelerators and instruments required to perform analyses using nuclear methods. The U-120 M Cyclotron is a unique source of fast neutrons, which is used for studying nuclear reactions, preparing radionuclides for research, and for producing radiopharmaceuticals. The electrostatic Tandetron 4130 MC accelerator is used for the analysis of materials using ion beams and their modification through ion implantation. The experimental equipment instruments installed on the neutron radiation channels of the LVR-15 reactor (Řež Nuclear Research Institute) are used for performing the structural and elemental analysis of materials using neutrons. The facility is included amongst the neutron physics facilities included in the European project NMI3 – ACCESS to Large Facilities.

Van de Graaff

The **Van de Graaff HV2500 Accelerator** is a proton accelerator operated by the Institute of Experimental and Applied Physics of the Czech Technical University in Prague. It is located on the premises of the Charles University Faculty of Mathematics and Physics in Prague's Trója District. Currently the apparatus serves as a source of polarised neutrons for a polarised target (constructed jointly by experts from the Charles University Faculty of Mathematics and Physics and the Joint Institute of Nuclear Research in Dubna, Russia) and as a source of accelerated charged particles for additional application experiments built on the accelerator's experimental channels and also for the needs of the Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague. The equipment is used not only for existing research programmes, including the collaborative activities with the Joint Institute of Nuclear Research, but also for new projects submitted by the European Space Agency. The accelerator also plays a very important role in the training and education of students.

Wind Tunnels

The wind tunnels are the property of the Aerospace Research and Test Establishment in Prague-Letňany and are physically located at two sites. The aerodynamic test facility for low speeds is in Prague 9 and the one for high speeds is in Prague 8. Both test facilities include several aerodynamic tunnels and the associated equipment (measuring and computer technology, test equipment, etc.), which is essential for performing applied and basic research in aerodynamics and fluid mechanics. The topics that are studied fall under the fields of thermodynamics and fluid mechanics and under certain areas of energy, aeronautics, aerodynamics, and civil engineering. The facilities are included in the European Windtunnel Association's Network of Excellence. Partnership agreements have been signed for various projects with Airbus UK, KTH Švédsko, Eurocopter France, Thales France, Airbus Germany, and Lidar UK. Thanks to its technical equipment and facilities, the Aerospace Research and Test Establishment is the coordinator for two international projects (CESAR and NACRE). At the national level, it works in collaboration with the Brno University of Technology, the Czech Technical University in Prague, various institutes of the ASCR, Škoda Auto, a.s., Škoda Electric, a.s., Škoda Energo, a.s., and PBS Velká Bíteš a.s. The most important outputs are the results from various tasks performed within the framework of individual implementation projects.

CEITEC – Nanostructure and Advanced Materials Section

CEITEC – the Central European Institute of Technology is a major project under the RDI OP, which has successfully completed the negotiations phase. The project aims to bring together the leading scientists in the fields of materials science research and life sciences research from several universities and institutes of the ASCR. The prerequisites for interdisciplinary integration and collaboration will also be established.

CEITEC will develop unique conditions for the development of research in the field of nanotechnology. Two shared laboratories (Nanolithography and the Preparation of Nanostructures; and the Characterisation of Nanostructures) will make it possible to carry out both a complete production process (using a bottom-up, top-down, or managed growth approach) as well as the characterisation of surfaces and nanostructures using analytical methods in an enclosed environment with a high level of purity (Class 100 to 1000 and measuring 850 square metres in area). The two shared laboratories are unique in the Czech Republic, both with respect to their organisation and operation (open access to research teams from CEITEC and external to it) as well as on the basis of the size of the pure environment and the broad scope of integrated planar technologies and analytical methods that will make it possible to prepare and characterise the entire spectrum of 2D – 0D nanostructures (<100 nm) on the basis of metal, semiconductor, and dielectric nanomaterials and their combinations. This objective is based on previous experience with the operation of existing pure facilities at the Faculty of Natural Science of the Masaryk University and the Brno University of Technology as well as from a number of projects associated with the research of planar nanostructures, such as for example the following Centre for Basic Research studies: Structures for nanophotonics and nanoelectronics; Functional hybrid nanosystems of semiconductors and metals with organic materials; the Nanotechnology for Society programme, and the European FP7 – NanoCharM project.

The shared Structural Analysis Laboratory will complement the above facility with high-resolution transmission electron microscopy (including local chemical analysis and diffraction) and high-resolution raster electron microscopy (including local elementary analysis and reflection electron diffraction), which can be applied in either a high or a low vacuum environment.

b Large infrastructures abroad of which the CR is an official member

CERN

CERN is an intergovernmental organisation for elementary particle research that is headquartered in Geneva, Switzerland. CERN operates an extensive system of accelerators, including the world's largest accelerator – the Large Hadron Collider (LHC). Scientific collaboration with CERN is coordinated by the Committee for the Cooperation of the CR with CERN, whose members include representative from collaborating institutions as well as representatives from the Ministry of Education Youth and Sports, the Ministry of Finance, and the Ministry of Foreign Affairs. The Czech Republic is involved in a number of experiments carried out under CERN. From the perspective of scope and the importance of the contributions made by the Czech teams, the most important is the ATLAS experiment performed using the LHC. Over sixty physicists, students, engineers, and technicians from the Academy of Sciences of the CR, Charles University, and the Czech University of Technology are involved in ATLAS in the Czech Republic. They have participated in the initial design and construction of several parts of the ATLAS detector, in the development of the software, and in the preparation of the physics programme. Another major experiment carried out using the LHC and in which the CR is actively participating is the ALICE experiment, which is focused on heavy ion collisions and shows promise of providing information that will be important for verifying current theories on the origins of the universe. A contact point has been established with the CzechTrade Agency for cooperation with Czech industrial enterprises. The Czech Republic is one of the most successful CERN members with regard to obtaining commercial orders.

Tevatron – Fermilab

The Tevatron is an accelerator used for studying the collisions of antiprotons with protons. It is located in the largest American elementary particle physics laboratory – the Fermi National Accelerator Laboratory (Fermilab) near Chicago. The detector used in the D0 experiment at Fermilab was developed as the result of international collaboration using this accelerator. The Czech Republic has been a member of the collaborative team since 1996 and has contributed to the project by processing

the collected data at the Regional Particle Physics Computer Centre at the Institute of Physics of the ASCR. Approximately fifteen scientists, PhD students and technicians are involved in the physical analysis of this processed data. Czech institutions contribute towards the operation and maintenance of the observatory through the MEYS INGO and Research Centres' programmes. The experience gained from the processing of the data for this experiment and the physical analysis of this data is of great importance for preparing the young scientist who will participate in the ATLAS experiment at CERN.

Pierre Auger Observatory

The Pierre Auger Observatory in Argentina's Mendoza Province is the result of international collaboration. The observatory specialises in studying the spectrum and composition of the highest energy cosmic rays. The Czech Republic has been a member of this collaborative effort since 1999. The main material contribution the CR has made consists of twelve mirrors, each measuring approximately twelve square metres, for one of the observatory's fluorescent telescopes. In addition to the aforementioned telescopes, the observatory also operates a network of terrestrial detectors distributed over an area of approximately 3000 square kilometres. Czech institutions contribute towards the operation and maintenance of the observatory through the MEYS INGO and Research Centre programmes. Approximately twenty scientists, PhD students and technicians are involved in collecting and analysing the data from the fluorescent telescopes and in the modernisation of the observatory. In the future, the observatory will be supplemented with a similar network of terrestrial detectors and fluorescent telescope in the northern hemisphere, which will be located in the USA.

LSM/JOULE

The LSM/JOULE facility (Laboratoire Souterrain de Modane/ JOint Underground Laboratory in Europe), located in France, covers much of the subject matter included in current physics research. The research activities are carried out in underground laboratories and include studies associated with double beta decay, neutrino oscillation in the field of neutrino physics; dark matter detection; the measurement of very low radioactivity levels; new detection structures for ultra-sensitive measurements; removal of radioactivity from the air and material samples, and the testing of semiconductor technology. The Modane Underground Laboratory (LSM) is located in France and has rock coverage of 4800 m.w.e. It was established in 1982 as a facility for performing experiments requiring an extremely low background environment. The Czech Republic has been significantly involved in the NEMO 3 and TGV II experiments on a long-term basis. At the beginning of this year, preparations started for a significant expansion of the existing LSM/JOULE laboratory with an estimated project cost is EUR 15 million. This is a continuation of the TGV III (study of double electron capture measured using pixel detectors), the SuperNEMO experiment (study of neutrino-free double beta decay, 100 kg of enriched isotope), the project involving a low background HPGe detector with a volume of 600 cubic centimetres and the COBRA experiment (study of 116Cd double beta decay using pixel detectors).

ESRF & ESRF Upgrade

Synchrotron radiation is essential for modern research in many areas of basic and applied research associated with new materials and molecular and biological structures. The European Synchrotron Radiation Facility v Grenoblu (http://www.esrf.eu) generates the most intense synchrotron radiation in all of Europe. The Czech Republic has been officially involved in ESRF since 1999 and is formally represented by the Institute of Physics of the ASCR. The ESRF Upgrade, planned to be completed between 2009 and 2018, will provide users with new opportunities, particularly in the fields of nanotechnology, structural biology, fast processes, the behaviour of materials under extreme conditions, and the development of X-ray imaging methods.

ILL

The Max von Laue and Paul Langevin Institute in Grenoble (http://www.ill.eu) operates the most intense stationary neutron source in the world, which is connected to approximately forty unique measuring apparatuses that use neutron beams for modern experimental research in various scientific disciplines, including physics, chemistry, materials science, biology, and others. The CR has been one of the ILL's ten scientific partners since 1999. The Faculty of Mathematics and Physics of the Charles University in Prague has been charged with representing and administering the Czech Republic's interests within ILL. The Czech Republic's long-term participation in ILL plays a key role in ensuring that the Czech scientific community has stable access to modern methods that using intense neutron beams. Financial resources are required to cover membership dues and additional costs.

ThALES (ILL 20/20 upgrade)

Facilities at the ILL are continuously developed with the goal of optimising parameters and making it possible to perform experiments that could not be carried out in the past, thus significantly increasing the scientific benefits enjoyed by the partnering countries. The modernisation of the ILL facilities is now the subject of the ILL20/20 (Upgrade) project under the ESFRI Roadmap. As a part of the ThALES project, the Charles University Faculty of Mathematics and Physics intends to construct a next-generation three axis spectrometer at the ILL facilities, which will be used for studying low-energy inelastic neutron scattering. In compensation, ILL will provide the Czech team a direct (i.e. without a tender) allocation of fifty days at the ThALES facility over the course of the first two years following the final building approval and two years of training for two PhD students beyond the extent of the rights the Czech Republic currently has. Financial resources are required as a contribution to the construction of the spectrometer and to cover additional costs.

ESS

The **ESS - European Spallation Source - Scandinavia** (http://ess-scandinavia.eu/) in Lund, Sweden, will be a pan-European facility (complementary to the ILL) focusing on multidisciplinary advanced materials research using neutron scattering methods after 2020. The research areas that will benefit from the ESS include materials science, nanoscience, chemistry, molecular biology, biotechnology, pharmacology, energy, and microelectronics. The spallation source will generate intense pulsed neutron beams using the spallation process rather than a conventional nuclear reactor, which generates continuous beams. The methodologies using pulsed and continuous neutron beams are complementary in many respects. The Czech Republic's participation in the ESS is highly desirable, as it will help to maintain the excellent reputation Czech scientists have in relation to the use of unique neutron scattering methods in modern materials research. Financing is required during the 2010 to 2015 period in order to ensure the effective participation of the Czech neutron community in the construction phase and to provide training for young Czech scientists and students in the form of internships at already easting laboratories that use spallation sources. An opportunity for Czech scientists to participate in the construction of a unique neutron diffractometer for studying materials under extreme conditions has been negotiated with the ESS managing board. The project guarantors are the Institute of Nuclear Physics of the ASCR and the Charles University Faculty of Mathematics and Physics.

ELETTRA – MSB

The ELETTRA in Trieste is a modern third-generation synchrotron with twenty-two optical paths. The energy range of the synchrotron radiation generated by ELETTRA (120 eV - 8 keV) makes it complementary to the ESRF in the field of low energies. The Czech Republic constructed the Materials Science Beamlines (MSB) at the ELETTRA facility. The MSB is administered by the Charles University Faculty of Mathematics and Physics in cooperation with the Institute of Physics of the ASCR. The Czech Republic is the only country of the former Eastern Bloc (other than Russia) that now has its own optical path at any synchrotron. The MSB provides measuring time on a unique cutting-edge apparatus for photoelectron spectroscopy to interested parties from the general scientific community.

GSI

The GSI Helmholtz Centre for Heavy Ion Research, located in Darmstadt, Germany, is involved in basic and focused research involving heavy ion physics and related fields. Czech physicists have been successfully cooperating with GSI for almost twenty years. They have participated in the TAPS experiment and are currently involved in the international HADES experiment, which is focused on studying the properties of vector mesons in dense baryonic matter. At this time ten physicists, engineers and technicians from the Institute of Nuclear Physics of the ASCR and the Charles University Faculty of Mathematics and Physics are participating in the HADES experiment. Thanks to

the significant participation of Czech researches, the HADES detector is currently being supplemented with additional detector subsystems in preparation for performing the experiments included in the first phase of the FAIR project, which will be performed at the GSI facility.

ESO

The European Southern Observatory (ESO) is a non-governmental European organisation for performing spaces research in the Southern Hemisphere. It has fifteen members, including the Czech Republic. ESO operates astronomical telescopes located in La Silla and on Mt. Paranal in Chile's Atacama Desert. ESO's mission is to collaborate at the international level for the purpose of performing top level scientific research, implementing major astronomical projects, developing new instruments, focusing on new technologies, expanding the scope of European cooperation, participating in educational programmes, and creating programmes for the general public. In addition to participating in space research using the world's largest telescopes and its access to the ESO-ESA infrastructure, the Czech Republic also has access to cutting-edge technologies that have application potential in many other fields, thus making it possible to be awarded unique contracts for producing high-precision services, electronic control systems, remote control systems, optical assemblies, and high-precision mechanical systems.

Table

Name of the large infrastructure in the CR	Brief description	Infrastructure type	rok dokončení
ELI	Interaction between radiation and mass in the ultra-relativistic regime	ESFRI	Major project under the RDI OP
PALS	Unique high-performance laser	National	Existing
MLTL	Set of unique apparatuses for performing experiments associated with magnetism and low temperatures	National	Existing
LNSM	Comprehensive equipment for performing research associated with functional nonmaterial and semiconductor nanostructures	National	Existing
SAFMAT	Laboratory for performing the characterisation of nanostructured functional materials	National	2013
CANAM	Accelerators and experimental equipment for studying the interaction of materials with ions and neutrons	National	Existing
Van den Graaff	Source of charged particles and neutrons	National	Existing
Wind tunnels	Unique facility for performing research involving ultrasonic and subsonic flows	National	Existing
CEITEC – Nanostructured and advanced materials section	State-of-the-art infrastructure in the field of nanotechnology and advanced materials	National	The independently functional base for a shared infrastructure exists; a major project under the RDI OP for 2014/2015

Table

Name of the large infrastructure abroad of which the CR is an official member	stručný popis	typ infrastruktury	rok dokončení
CERN	Set of facilities for performing elementary particle research	International organisation	Existing
Tevatron Fermilab	Facilities for studying proton and antiproton collisions	International experiment	Existing
Pierre Auger Observatory	Facilities for studying ultra-high cosmic radiation	International experiment	Existing
LSM/Joule	Neutrino physics laboratory	International experiment	Existing
ESRF & ESRF Upgrade	Source of high-intensity synchrotron radiation	International organisation	Existing; upgrade included in the ESFRI Roadmap
ILL	Stationary intense neutron source	International organisation	Existing
ILL 20/20 Upgrade (ThALES)	Three axis low-energy spectrometer for the ILL upgrade	International experiment	Upgrade included in the ESFRI Roadmap
ESS	European facilities for multi-disciplinary research in advanced materials research	International project	2016
ELETTRA MSB (Material Science Beamline)	The Czech-operated Materials Science Beamline at the ELETTRA Synchrotron in Trieste	International organisation	Existing
GSI Helmholtz Centre for Heavy Ion Research	Accelerators and detectors for heavy ion physics research	International experiments	Existing
ESO (European Southern Observatory) & Centre for the ESO – ESA - NASA	Unique set of astronomy instruments for investigating the sky in the southern hemisphere	International organisation	Existing; upgrade is included in the ESFRI Roadmap

3.4 Promising Projects

HiLASE

HiLASE – New Lasers for Industry and Research is a project involving a research and application centre for repetitive pulse lasers. This is a strategic project aimed at helping the Czech Republic attain a leading position in the implementation of large laser infrastructures. It is focused primarily at the development of cutting-edge lasers with a high repetition frequency and on laser systems that can be used by industry and small and medium-sized laboratories as well as by future large European facilities. The project is specifically focused on lasers using the highly promising diode pumped solid-state laser systems and on the development of the related technologies. The HiLASE project includes the most modern laser technologies (i.e. lasers with high maximum and high average performance), which have extensive application potential for such projects as the future large pan-European ELU and HiPER facilities.

The project was submitted within the framework of Priority Axis 1 – Regional research and development Centres under the Research and Development for Innovation Operational Programme and it was recommended for financing. Since September 2010, the project is in the negotiation phases. The Institute of Physics of the ASCR is heading the project. The building will be located in Dolní Břežany in the Central Bohemian Region.

XFEL

The XFEL X-ray Free Electron Laser (http://www.xfel.eu/) which is under construction in Hamburg, Germany is a facility that will supply intense X–ray radiation that is 107 times more intense than the radiation currently attainable from femtosecond flashes. This will make it possible to perform many experiments that could not be carried out previously and to find solutions to new issues in the fields of nanoscience, structural biology, solid state physics, and femtochemistry as well as in the material sciences and plasma physics. Participation in this project is very desirable for the Czech scientific community, as it will help to maintain the reputation of excellence that Czech scientists have in the application of unique X-ray scattering methods in modern materials research. Czech scientists from various disciplines will thus have the opportunity to participate in the development of instruments, detectors, X-ray optics, and the XFEL control systems. It will also be possible for research teams to participate in planning the experiments performed using the XFEL facility. Financing is required for the 2010 to 2014 period in order to ensure the effective involvement of the Czech neutron community during the construction phase and to provide education and training for young Czech scientists and students in the form of internships at the facilities in Hamburg.

SPIRAL2

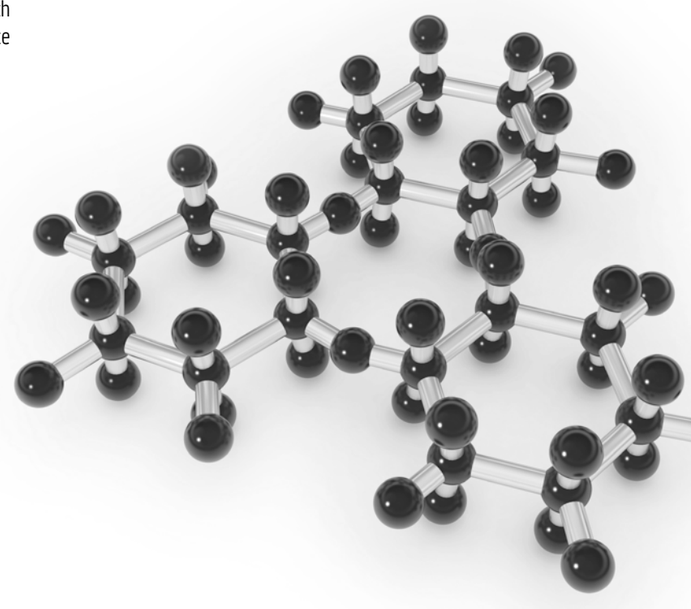
SPIRAL2 (http://www.ganil.fr/research/developments/spiral2/index.html) is a newly planned ESFRI facility that will expand the most well-known French nuclear physics laboratory – GANIL (http://www.ganil.fr). The facility will produce primarily radioactive beams (although intense stable ion beams will be produced as well) using the Isotope Separation On-Line (ISOL) technique. Thus far the cooperation that exists between the Nuclear Physics Institute of the ASCR and GANIL has been and continues to be partially supported on the basis of the ASCR – IN2P3 agreement. The development and completion of the SPIRAL2 facility is currently underway. SPIRAL2 will ensure international competitiveness for the GANIL laboratory as early as in 2015, at which time the operations of the facilities will meet the planned specifications. The SPIRAL2 laboratory will include unique equipment for neutron generation that can also be used by the field of nuclear astrophysics.

FAIR

The FAIR (Facility for Antiproton and Ion Research) (www.gsi.de/fair/index_e.html) is a unique experimental complex that support experiments with antiproton and heavy ion beams. This new project, which will be completed on the premises of the GSI Darmstadt premises in Germany, is planned as an international, although primarily European research centre and is included in the ESFRI Roadmap. FAIR includes an accelerator complex consisting of several new accelerators, storage rings and new experimental equipment. This complex will generate proton, antiproton, heavy ion, and exotic radionuclide beams with energies of up to an as of yet unattainable 35 GeV, making it possible to study physical processes under extreme conditions that have thus far never been accessible for experiments. Czech physicists have been cooperating with their colleagues from GSI for almost twenty years. They are involved in the TAPS, HADES and CERES experiments.

Centre for Cooperation with ESO and ESA

The Czech Republic's scientific cooperation with ESO is coordinated by the Astronomical Institute of the ASCR, which established the Centre for Cooperation with ESO and ESA. The Centre makes it possible for all research facilities involved in astronomy research with the appropriate focus and at the required level to participate in the research programmes to which the Czech Republic has access. As is the case with ESA, ESO also makes it possible for consortia comprising research facilities and companies from the industry sector to participate in the contracts to provide equipment and facilities. The Czech Republic will shortly join some of the ESO elective programmes, thus increasing the opportunities that Czech entities and individuals have to participate in individual projects. Both the Astronomical Institute of the ASCR as well as the Institute of Plasma Physics of the ASCR are also participants in the project for preparing the construction of the European Solar Telescope (EST), which will support the observations performed using the ALMA interferometer from another ESO project.



4 Energy

4.1 Current Status

Energy plays a major role in contemporary human life, as it is impossible to satisfy the demands of a dynamically developing society without a stable long-term supply of energy. Additionally, energy has a far-reaching impact on the environment. In 2009, the consumption of primary energy in the Czech Republic was provided through a mix of various sources (58.9% from steam power plants, 33.1% from nuclear power, 3.6% from hydroelectric sources, 3.9% from combined gas-steam and combustion, and 0.5% from wind farms and solar sources). Various tendencies are becoming evident in the CR with regard to the production and consumption of electric energy. Specifically there has been a decrease in consumption (since 2000, the average annual economic growth has been 4.5% but the consumption of energy has increased by only 2% annually), but it has been combined with a great increase in the installed power of smaller renewable energy sources (wind farms, photovoltaic sources, and biomass) together with the associated increasing demands for electric power transmission. Currently, the most important issues in this area deal with security and the improvement of the safety aspects of nuclear energy, including checks of the radiation load.

Due to its strong links with industry, research in the energy sector is roughly the same as the industrial structure of the companies operating in the relevant sector. Energy research is primarily focused on the issues associated with conventional energy, nuclear energy and, most recently, with renewable energy sources and the transmission of electric power. In the Czech Republic, energy research is fragmented and is distributed between many institutes (including universities, the Academy of Sciences of the CR, and corporate science institutes).

The need to develop modern large infrastructures in the energy sector significantly exceeds the options and capacities of the individual institutions and even of the entire country. The Czech Republic's membership in the EU brought with it the opportunity to effectively concentrate resources through participating in pan-European projects. However, even in this scenario the Czech Republic's efforts should be focused on developing the scientific and innovation base in the Czech Republic and the systematic involvement of Czech companies in the construction of Czech and European large infrastructures. The Czech Republic should not limit itself to only sending Czech workers abroad, but it should also be involved in basic research at local institutions with the participation of foreign scientific and technical employees (e.g. the reciprocity of cooperation and the establishment of laboratories in the CR).

Large energy infrastructures can be separated into several areas as follows: fission reactors (of various generations); facilities focusing on nuclear fusion (various methodologies); facilities that provide conventional energy; and facilities that focus on renewable energy sources.

The following paragraphs present an overview of the current status of Czech large energy infrastructures.

LVR-15 and LR-0 Reactors

The LVR-15 and LR-0 Reactors are located at the Řež Research Centre. The LVR-15 reactor was built and brought into operation in 1957 as an experimental facility to meet the needs of reactor and neutron physics. The reactor has been upgraded several times, with the last time being in 2007, and its current operating output is 10 MW. A series of horizontal and vertical channels for released neutron beams, high-pressure loops, and the reactor's thermal chamber are used to carry out experiments. The reactor is also fitted with pneumatic mail for transporting irradiated samples and hot cells for experimental purposes. Irradiation experiments are focused primarily on studying the changes in the physical and chemical properties of materials that occur as a result of radiation. The released beam of epithermal neutrons is used to perform medical and biological research. The horizontal channels are used for basic

and applied research. The facility has 115 permanent employees, of whom twenty-three are scientists. There are eleven teams of external users and about seven teams of users from abroad (Slovakia, Israel, Latvia, Russia, Poland, France, Germany, Italy, and Greece), who use the available facilities on a regular basis. The reactor's capacity is also permanently used by several user teams from the industry sector. The research performed using the LVR-15 reactor facilities is focused primarily on applications.

The LR-0 reactor was brought into operation in 1972 and was last upgraded in 2008. The experimental programme focuses on reactor physics associated with the active zones of pressurised reactors, storage racks, model experiments on VVER-1000 and VVER-440 type reactors to identify the spectra of mixed photon and fast neutron fields (the inputs used to determine the radiation load placed on the internal structural components and pressurised vessels and to make precise estimates of the estimated remaining life of the components of the reactor's pressurised vessels. Experiments in reactor and neutron physics are also performed to perform computer code validation, to verify certain parameters of new types of active zones for more advanced reactors that are intended for deployment and inclusion in international cooperative efforts to develop new technologies for terminating the fuel cycle (Molten Salt Reactor). Only five facilities of this type operate in Europe. The measurements that are performed help to improve nuclear safety and increase the effectiveness of the operations of nuclear plants and storage facilities for spent nuclear fuel. The facility has twenty-five permanent employees, of whom eleven are scientists. Three internal research teams and an additional two teams from abroad use the facilities on a regular basis.

COMPASS Tokamak

This device was transported from the Culham Science Centre in Great Britain and installed in the newly constructed building of the Institute of Plasma Physics of the ASCR at the Na Slovance site in Prague. This equipment is used for the experimental study of magnetised hot plasma physics. The COMPASS tokamak is geometrically similar to the ITER tokamak and two other large European tokamaks, specifically the ASDEX Upgrade in Garching, Germany, and the Joint European Tokamak (JET). The scientific programme is based on the actual needs of the ITER international project, which aims to demonstrate a successful technological solution for thermonuclear

fusion. Given the similarity of the magnetic configurations of the ITER and COMPASS tokamaks, it was decided to focus on two main topics: the study of boundary plasma, and the interaction between electromagnetic waves and plasma. The partner organisations for this project comprise the Charles University Faculty of Mathematics and Physics, the Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague, the Institute of Physics of the ASCR, the J. Heyrovský Institute of Physical Chemistry of the ASCR, and the Řež Nuclear Research Institute. At the international level, the project is coordinated by EUROATOM. Research is carried out by more than four internal teams, particularly in the field of materials physics, and by a number of international cooperating teams (from France, Austria, Belgium, Italy, Great Britain, Georgia, Poland., Bulgaria, Russia, Hungary, and Portugal). At this time, two industrial companies are participating in the project (Škoda Research and Vítkovice – Research and Development). It is expected that cooperation from the industrial sector will grow as activities are developed further. The COMPASS Tokamak has thirty-four employees, of whom twenty-two are scientists.

VR-1 Training Reactor

The VR-1 reactor was constructed in 1990 at the Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague. Due to its low output, this reactor is primarily used for educational purposes (4-5 PhD students, 6-8 Master students, and 3-5 Bachelor students per year) in the fields of nuclear safety and for the development of control systems for nuclear facilities. The VR-1 reactor has sixteen employees, of whom eleven are academicians. The workplace is equipped with two horizontal and five vertical channels, which are being prepared for scientific use.

National Radiation Protection Institute, a non-profit organisation (NRPI)

The National Radiation Protection Institute was established in the Czech Republic in 1995. In 2010, it was transformed into a public institution. The Institute plays an irreplaceable role in protecting the Czech Republic's population against the harmful effects of ion radiation. An important infrastructure in the field of radiation protection was developed at the institute. It joins several complementary laboratories, for example, for alpha, beta and gamma spectroscopy (eight HPGe detectors); radiochemistry; RTG; and radon diagnostics. The inclusion of the Institute in the Czech Roadmap for scientific infrastructures is important from the perspective of improving the safety and control over nuclear facilities.

The ESFRI 2008 Roadmap for European Large Infrastructures also includes the following energy projects that are at various phases of implementation: the Jules Horowitz high-flux reactor (JHR); the International Fusion Materials Irradiation Facility (IFMIF); the High Power Energy Research Facility (HiPER), and MYRRHA – a multi-purpose hybrid research reactor for high-tech applications. At this time ESFRI is discussing an update to the ESFRI Roadmap in the field of energy.

At this time there are no large infrastructures of European or at least national significance in the Czech Republic as far as research and development for conventional energy and renewable energy sources are concerned. However, in 2010 two important projects were approved to receive funding from the RDI OP, specifically the project for the Centre for Research and Utilisation of Renewable Energy (CVVOZE) submitted by the Brno University of Technology and the project for Innovation for Efficiency and Environment Energy Resource Centre (INEF) submitted by the VŠB – Technical University in Ostrava. In addition to the organisations involved in these projects, there are many Czech entities, including university faculties and institutes, the institutes of the ASCR, and private companies, which are involved or plan to become involved in the entire range of research and development issues that exist in relation to conventional energy and renewable energy sources (highly efficient modern coal blocks, including technologies for capturing and storing CO2 emission; smart grids; the use of biomass for energy; wind and solar power; geothermal energy; fuel cells; superconductivity; and others). These research facilities are typically smaller (usually with a staff of ten to twenty) and operate smaller already existing facilities (investments of approximately CZK 1 million). On the other hand, these facilities are characterised by the intensive level of education that they provide (ten to twenty PhD students per five years per facility), which proves that they are attractive to students. This particular area of research is also characterised by its strong links to industrial companies. International cooperation tends to occur more at the regional level (several specific partners from abroad). The level of cooperation with common technological initiatives and European technological platforms is not satisfactory (there is a lower level of representation on the part of the CR in technological platforms).

On the basis of an analysis of the current status, it is apparent that the need exists to develop experimental research bases in the Czech Republic that are in line with the international and European aims for research and development (e.g. increased investments in national experimental and development facilities, and more participation by foreign experts in the research and development activities performed in the CR). In the field of nuclear energy, it is necessary to expand the national infrastructures, i.e. the LVR-15 and LR-0 reactors, the COMPASS-D tokamak, and the VR-1 training reactor. The Řež Research Centre (the LVR-15 and LR-0 reactors) has strong links to industry (ČEZ, a.s.) and to European nuclear structures such as the OECD/NEA. The presence of a local tokamak is vital for ensuring the meaningful involvement of Czech facilities in the ITER thermonuclear fusion project. The VR-1 plays an enormous role in the basic training provided to young experts. In the case of all of the national large infrastructures, it is necessary to strictly apply the principle of open access based on free competition for the projects. This applies to both Czech as well as foreign users. In the areas of conventional energy and renewable energy sources, 2010 saw positive developments. Activities were launched for constructing two important research infrastructures in the Czech Republic – CVVOZE and INEF. One of the positive effects of these centres might be a stronger level of cooperation between other Czech entities operating in the field of conventional energy. It is also essential to greatly increase the participation of Czech facilities in international cooperation and the ESFRI initiatives.

4.2 SWOT Analysis

Strengths

- Energy research and development in the Czech Republic covers all areas associated with energy production and use;
- A strong tradition in conventional fossil fuel energy and nuclear energy;
- Close ties to the industry sector;
- Good scientific results in the past; and
- Training and education for students is provided in all of the main fields of energy, including renewable sources.

Weaknesses

- Research in the fields of conventional energy, renewable sources, and intelligent networks if highly fragmented;
- No existing large modern infrastructures for conventional energy, renewable resources, and intelligent networks;
- Limited cooperation between facilities;
- Unhealthy competitive environment, which prevents the establishment of distributed infrastructures and increased closer cooperation; and
- Limited remaining live of the LVR-15 and LR-0 reactors and the financially and operationally demanding upgrade of infrastructure for nuclear research.

Opportunities

- A strategic area of great importance, particularly in the near future;
- The priorities specified in the National Energy Policy, including the opportunities and requirement to comply with these priorities;
- Existing opportunities to participate in ongoing European projects (e.g. ESFRI) and established platforms; the ability to apply approaches and experience from abroad;
- Opportunities to perfect the monitoring in place for nuclear facilities in the Czech Republic; and
- Opportunities to participate in the Structural Funds, the RDI OP in particular, and, thanks to these investments, the ability to establish facilities at a national and/or European level, which have ties to international research.

Threats

- A potential lack of human resources is anticipated in the energy sector post-2015 and it could have a negative impact on science and research in this area;
- Problems with ensuring open access to certain large infrastructures;
- A failure to involve all of the research groups active in research and development in the processes for developing research facilities;
- A lack of interest on the part of facilities to participate more in cooperative efforts and the elimination of fragmentation in certain fields; and
- Intensive cooperation with facilities aboard results in the migration of excellent researchers without any certainty of their return to their original workplaces.

Proposed Solution

A national integrated system of large infrastructure built on the LVR-15 and LR-0 research reactors (Řež Research Centre) will be established. The reactors must be continuously upgraded (in cooperation with the Ministry of Industry and Trade, the Řež Nuclear Research Institute, and ČEZ, a.s.) and it is necessary to ensure open access for Czech and foreign users (an international panel for assessing scientific experiments and projects, a mandatory grant system to support projects submitted by other facilities, management and scientific positions awarded through international tenders, and others). As far as new nuclear fission technologies are concerned, the ongoing project for the Jules Horowitz Reactor (JHR) is of key importance. It is expected that this facility will be brought into operation in 2014. For this reason we recommend that support be provided for the Czech Republic's participation in this project (the CR is represented by the Řež Research Centre). We believe that a lower priority should be given to supporting the Sustainable Energy project, which is involved in the research of new reactor technologies with specific impact in the Czech Republic's regions (Pilsen).

In the area of thermonuclear fusion, it is necessary to provide a reasonable amount of support for fusion technologies that provides a solution to ambitious challenges and which offer opportunities for intensive foreign cooperation and impact a number of publications and results in basic research, however without any direct impact on actual energy for a period of at least the next twenty years. In addition, the groups involved in fusion research are not greatly differentiated or horizontally active throughout the CR. For this reason, we recommend that that support be provided to the projects for establishing the large infrastructures associated with the COMPASS tokamak and ITER (currently being prepared) under the same conditions as those specified for the reactor projects (an international panel, a mandatory grant system to support projects submitted by other facilities, etc.). It is also necessary to support the HiPER project as an independent foreign large infrastructure. This particular project is currently in the design phase. Construction is expected to start in 2015 and operations should commence in 2018.

With regard to the Czech Republic's energy policy, the most important sources for the near future (the next ten to fifteen years) consist of the modern use of waste and fossil fuels, including the capture and storage of CO2 emissions, as well as the development of renewable sources, such as second generation liquid biofuels, photovoltaic sources, geothermal energy, smart grids, and hydrogen energy. It is also necessary to strengthen research and development research options in the field of non-nuclear energy. At this time two research centres are being established using funding from the RDI OP, specifically the CVVOZE project at the Brno University of Technology and the INEF project at the VŠB – Technical University in Ostrava. New initiatives will offer further opportunities to coordinate activities in the Czech Republic and to start participating in existing European platforms. Once the research facilities have been fully completed, new important research projects can be expected, most likely in the form of direct involvement in a selected European project focused on developing the national research base.

4.3 High-Priority Projects

LVR-15 and LR-0 Reactors

These reactors are the largest national infrastructure in the field of reactor physics and a significant level of cooperation with the industry sector exists in this area. In order to meet research needs in the Czech Republic, it is necessary to ensure their operations and support their further development (primarily on the part of the Ministry of Industry and trade, ČEZ, a.s., and the Nuclear Research Institute). The infrastructure is a part of the Řež Research Centre.

JHR

The Jules Horowitz Reactor is a European project. An 80% share of the participation in this project consists of the involvement of the CEA, EDF and AREVA. The Czech Republic has a 2% share. The total referential project costs are EUR 500 million. The Czech Republic is represented in the JHR project by the Řež Research Centre.

COMPASS and ITER Tokamaks

The COMPASS tokamak is a large infrastructure at the national level. The facilities are used to perform experimental research associated with magnetised hot plasma. The COMPASS tokamak is geometrically similar to the ITER tokamak and two other large European tokamaks, specifically the ASDEX Upgrade in Garching, Germany, and the Joint European Tokamak (JET). The ITER project is currently being prepared as an international project with European participation in the field of thermonuclear fusion. The Czech Republic is represented in this project by the Institute of Plasma Physics of the ASCR.

HiPER

HiPER is a European project that is in the preparatory phase. The plans include the construction of this facility in Great Britain and operations are scheduled to commence in 2018. HiPER is a laser-driven fusion demonstrator. The Czech Republic is represented in this project by the Institute of Physics of the ASCR.

Table

Name of the large infrastructure	Brief description	Infrastructure type	Year of completion
LVR-15 and LR-0 Reactors	Fission reactors	National	Existing
JHR	Next generation fission reactor	ESFRI	2014
COMPASS and ITER Tokamak	Magnetised hot plasma – thermonuclear fusion	National and international	Existing and 2020
HiPER	Laser-driven fusion demonstrator	ESFRI	2018

4.4 Promising Projects

VR-1

The VR-I is a university-operated nuclear reactor that plays a key role in the education and training of nuclear power plant workers. However, it also has research potential for use in international and national cooperative efforts within the Czech Nuclear Education Network. The VR-1 training reactor is a cutting-edge experimental facility used in the Czech Republic for educational purposes in the field of nuclear engineering, and for research and development associated with nuclear facility safety, theoretical and experimental reactor and neutron physics, nuclear safety, and the nuclear fuel cycle. The research and development that is performed using the reactor account for approximately one-fifth of the reactor's total operations. It is limited primarily due to the reactor's relatively low output capacity. For this reason, the research and development tasks are focused primarily on the preparation and improvement of educational tasks, the comparison of the calculations for various reactor parameters with experimental results, the study of the dynamic properties of multiplicative systems, the development of control systems, the calibration of detectors, the verification of atypical neutron variables, etc. The importance of the VR-1 infrastructure is associated with the anticipated construction of new nuclear sources in the Czech Republic.

National Radiation Protection Institute, a non-profit organisation (NRPI)

The NRPI is an existing national infrastructure in the field of nuclear safety. It plays a key role in monitoring the radiation situation in the Czech Republic. The Institute has an existing infrastructure for low-background spectroscopy for various types of radiation. The Institute cooperates with national and international facilities that have a similar focus.

CVVOZE

The Centre for Research and Utilisation of Renewable Energy (CVVOZE) project is aimed at establishing a research centre involved in investigating the options for the efficient and sustainable use of energy within the existing context. The main directions that the research will take include investigating the possibility of integrating sources into the power system; the equipment required for the transmission and distribution of electricity; intelligent networks; the accumulation electric energy; and the components required for the electronic transport, diagnostics and optimisation of processes in the field of electric energy. The Centre will include a laboratory complex, the most important of which include a short-circuit testing station, an ultra-high voltage laboratory, and a climate chamber equipped vibration equipment. Once the centre is completed, it will employ forty researchers.

INEF

INEF is a project aimed at establishing a regional research and development centre that will be involved in three different research programmes. The first programme involves heating innovation; the second focuses on technologies for the gasification of biomass and the production of next-generation biofuel; and the third aims to improve the safety of energy technology. The total costs for the project have been set at CZK 210 million.

Sustainable Energy

This project aims to establish a centre for the research, development and innovation associated with long-term sustainable energy. The objective is to develop a centre for the theoretical and experimental investigation of processes and materials, including their subsequent practical application. The purpose of the centre is to seek to attain a certain level of safety for energy facilities, nuclear power plants in particular, and to ensure an acceptable level of environmental impact. The ultimate goal is to facilitate the replacement of conventional methods that use coal and oil, increase efficiency, decrease production costs, reduce CO_2 emissions, and recycle the largest possible amount of raw materials. Although the project has already successfully completed negotiation under the RDI OP and has been sent to the European Commission for a final decision, it is still included amongst the promising projects, as it is not clear which part of the project involves a research infrastructure and which part will be an important research centre.

5 Biomedicine

5.1 Current Status

The biological and medical sciences, also referred to as "biomedicine", "biomedical sciences" or "BMS", and the associated infrastructure encompass a very broad range of scientific disciplines, ranging from systems biology and basic and clinical research to the development of new biotechnical specialisations, which border on other areas, such as energy, environmental science, and climatology. All of these areas are covered by the ESFRI BMS in its "Grand Challenges" for the biological and medical sciences.

The worldwide development of biomedicine is highly dynamic and consequently the individual European states must also face global competition within this field. In the area of biomedical research, there are currently eight projects for new research infrastructures that are in the preparatory phase and five projects are just entering the construction phase. The establishment of these thirteen pan-European biomedical infrastructures reflects the explosive growth in the level of knowledge and plays a partial role in the birth of new interdisciplinary fields and in interconnecting the existing areas of research. The most dynamically developing fields include functional genomics, bioinformatics, imaging, and molecular structure analysis. The extremely rapidly developing field of translational medicine is aimed at the development of individualised medical procedures and personalised medicine.

Several expert groups in the Czech Republic successfully joined newly originating European biomedical infrastructures in 2009 and 2010. Just their inclusion in these organisations represents a great success for the development of our biomedical field, as it integrates our research facilities with leading European centres and, in the future, it will present opportunities for further intensification in the acquisition of know-how, expert exchange programmes, and the important profiling of our facilities within the global competitive arena. From the perspective of medical and biomedical research results and based on such things as the level of participation in the Sixth Framework Programme, the leading research institutions in the Czech Republic are without a doubt the First and Second Faculties of Medicine of the Charles University in Prague, in spite of the fact that the large infrastructure for biomedicine needs to be strengthened in this region.

Czech teams have been primarily involved in the following projects (a more detailed description is provided further in the text):

INFRAFRONTIER – a project in the field of functional genomics, which studies the function of genes with the goal of identifying potential therapeutic objectives;

EATRIS – a project in the field of translational medicine, which will transfer the results from basic research into clinical practice;

BBMRI – a project involving a network of clinical sample banks that collect data on clinically important biomarkers and potential therapeutic objectives;

CZ-OPENSCREEN – a project aimed at identifying new molecular instruments for basic research and new potential medications through screening libraries of chemical compounds;

the EURO-BioImaging and INSTRUCT projects in the fields of bioimaging and structural biology, which are establishing centres that use new technologies for, amongst other things, monitoring functions and the localisation of biomacromolecules; performing analyses of complex structures and the interactions of individual molecules;

projects involved with networks of clinical research centres (such as ICRC), which coordinate the research of new therapeutic procedures; and

ISBE – a systems biology project that combines the approaches from protein chemistry with molecular system and structural biology.

The newest projects to be added to the list include the project for the ELIXIR infrastructure in the field of bioinformatics, which integrates the needs of all structures active in biomedicine. Specifically, it processes, stores, and analyses the large amounts of bioinformatic data that are generated in all BMS disciplines; and the project for the National Centre of Medical Genomics (NCMG), which applies modern genomic analysis performed at the patient level for the development of new medical procedures.

The growth of Czech research centres within the context of pan-European infrastructures was also positively influenced by some of the projects submitted for the RDI OP and the Prague Competitiveness OP, which have either already been approved or the negotiations regarding them have been successfully concluded. These projects include BIOCEV, CEITEC, FNUSA-ICRC, BIOMEDREG, and CZ-OPENSCREEN. A combination of financing from the Seventh Framework Programme during the preparatory phases of the projects and financing from national sources and the Structural Funds during the construction phase of the Czech part of the projects, strongly influenced the CR's membership in the European infrastructures, however it in and of itself does not resolve the sustainability of the projects. In order for these new biomedical infrastructures, established as a result of the need for the further global development of BMS, to be capable of maintaining expert centres, playing an important role at the European and global levels, and effectively supporting scientific groups in the Czech Republic, the highest priority should be placed on resolving the issues associated with financing their sustainability and their open access, specifically their accessibility to leading researches on the basis of projects selected in an open tender.

Whilst the establishment, development and inclusion of Czech infrastructures (or, in some cases, future infrastructures) was very dynamic and successful in 2009 and 2010, biomedical research needs further revitalisation. There is still an apparent effort in the Czech Republic to cover as many BMS fields as possible, which has thus far led to maintaining or establishing scientific groups and institutions, even though the critical mass required for developing a specific scientific discipline may not be available. This results in both expert as well as financial problems, as many times requests are duplicated for instruments and technical equipment, which could otherwise be better utilised and could attain cutting-edge technological level within the framework of a concentrated expert infrastructure with open access. Interdisciplinary cooperative efforts, which would lead to the creation of new fields or projects, are rare. It is specifically in these situations that the aforementioned infrastructures, which are being developed and are connected to European projects and networks within the ESFRI framework, could represent the most basic effective bonding element for the further development of Czech basic and applied biomedical research.

Further effectiveness could be attained by linking the activities of the developing infrastructures with European scientific programmes, such as those that are included in the Seventh Framework Programme. The biomedical infrastructures that are being developed also have the opportunity to become incubators for the application science sector. Due to the lack of large biotechnical and pharmaceutical companies in the Czech Republic, the links to this sector are often accomplished with the help of small companies, which do not have the required know-how and intellectual property rights in the relevant area and which participate in some scientific centres only because of the requirement for the company to be involved. The majority of connections to Czech companies are only of local significance.

The new biomedical infrastructures have the opportunity to become true centres of excellence at the European and international levels, under the condition that they concentrate on the know-how associated with one or, at the most, a few small fields, which could, with sufficient state support, attain the level of critical mass required to develop a scientific environment (from the perspective of both personnel as well as technology), not only for maintaining the expertise involved, but also to enable it to develop further. Additionally, these centres will also support regional development of the biotechnical and pharmaceutical industries through their activities.

5.2 SWOT Analysis

Strengths

- Sufficient existing intellectual capacity, experience and human resources for a number of complete technological units;
- Individual groups strive to become involved in ESFRI Roadmap consortia; and
- Individual groups achieve excellent scientific results and contribute towards determining the direction in which scientific disciplines will develop at least at the national level.

Weaknesses

- Fragmentation of the infrastructures;
- Insufficient links between individual infrastructures and frequent duplication;
- The non-existence of a large biomedical infrastructure in the Czech Republic;
- Few potential national large infrastructures have links to the ESFRI Roadmap consortia;
- The research that is performed is very heterogeneous and it is therefore difficult to identify a common uniting topic;
- Too many local interests and specific objectives lead to the creation of small technological units, units focused on only one specific discipline, or a large number of scientific groups located at various facilities with minimal ties; and
- Isolated groups can only very rarely contribute to the excellent development of a particular field, group, or facility.

Opportunities

- There is an opportunity to create technologically advanced research platforms and incubators for progressive or new scientific disciplines;
- The establishment of large infrastructures with specialised know-how and with links to the international environment, such as the major European ESFRI projects, presents the opportunity to acquire top scientists from abroad as well as the opportunity to attract young promising Czech scientists back from long-term stays abroad;
- The involvement of top scientific centres at the national level will lead to a new scientific culture and more intensive international cooperation; and
- All of these effects will help us to profile our research and may create the prerequisite conditions for establishing applied research centres in the future. Thus far the Czech Republic has not had the proper environment for high-quality applied research and long-term preparations must be made in order to establish one.

Threats

- The absence of a uniform long-term concept for supporting research and development on the part of the major political parties;
- Without an adequate level of support, there might be a lack of personnel at various levels in spite of the fact that personnel capacity does exist;
- A lack of application research results used in the industry sector – the CR has a small industrial base that is capable of utilising the results from these infrastructures;
- Insufficient experience with managing large infrastructures; and
- The non-existence of platforms for BMS.

Proposed Solution:

In relation to the inclusion of biomedical projects in the Czech Roadmap, a communications platform for BMS infrastructures started to be established in 2010. This platform must be expanded even further to include centres of excellence and new centres and projects established under the RDI OP. The resulting links will gradually increase the level of experience with managing infrastructures and will help to update requirements in the Czech and European communities. A link to the European community, through, for example, integration with the ESFRI projects, will improve the links between the Czech infrastructures and scientific biomedical centres and the application sector, which can be developed in the CR only gradually. During the next period, it will also become necessary to look for a solution with regard to the sustainability of the infrastructures that cooperate in scientific activities at the level of the ASCR, various universities, and several ministries, in particular the Ministry of Education, Youth and Sports. Discussions at this level with the participation of scientific experts must lead to the creation of a long-term pragmatic concept for the development of the biomedical scientific base in the Czech Republic, with special emphasis place on a greater level of internationalisation, more openness and improved competitive strength.

5.3 High-Priority Projects

BBMRI Bank of Clinical Samples (BBMRI_CZ)

The Bank of Clinical Samples is an existing large infrastructure established and managed by the Masaryk Memorial Cancer Institute (MMCI) and is functionally linked to the Regional Centre for Applied Molecular Oncology (RECAMO) project under the RDI OP. The MMCI Bank of Clinical Samples was certified by the BBMRI steering committee as a Czech centre and associate structure and in the future it will be the national coordinator for the Czech part of the pan-European Biobanking and Biomolecular Resources Research Infrastructure (BBMRI) under the designation of BBMRI_CZ. The objective of BBMRI_CZ is to work under the sponsorship of the MMCI Biobank and to develop a network of biobanks in the Czech Republic, which will be responsible for the long-term storage of biological samples taken from patients under standardised and accredited conditions. This network will also include a newly developed biobank information system, which will enable communication between the Czech BBMRI_CZ centre and other European biobanks. The Masaryk Memorial Cancer Institute not only organises a unique bank of clinical samples of tumours, but also possesses the unique combination of technologies, skills, and knowledge required for the implementation of translational research and its clinical application, including the performance of clinical trials. The facility has the know-how to perform translation research in cellular biology, molecular oncology, and applied molecular oncology. Within the biobanking field, the MMCI Biobank will, even within the BBMRI framework, provide access to clinical samples and to the analyses of them in a manner that ensures that the analyses of the archived materials will contribute to the further development of prevention, diagnostic and therapy methods.

EATRIS/EATRIS-CZ

This key national infrastructure initiative for translational medicine was proposed under the BIOMEDREG "Biomedicine for Regional Development and Human Resources" project (www.biomedreg.eu), which is financed from the European Regional Development Fund through the Research and Development for Innovation Operational Programme, specifically under Priority

Axis 2 – Regional Research and Development Centres. This project involves the establishment of a new infrastructure – the Institute of Molecular and Translational Medicine (IMTM) – at the Faculty of Medicine of the Palacký University in Olomouc, which will serve as the national platform for molecular and translational medicine as well as the Czech node of European Advanced Translational Research Infrastructure in Medicine (EATRIS). The IMTM will coordinate national initiatives in translational medicine (EATRIS-CZ) and establish a national network of a number of important national infrastructures of a critical size. It will also ensure open access research in molecular and translational medicine. IMTM/EATRIS-CZ will cooperate with other comprehensive biomedical research infrastructures for the purpose of developing an infrastructure in Europe and in the Czech Republic, which will act as a communication interface between already existing infrastructures and specialisations with the goal of creating common added value, avoiding the duplication of activities, and improving the effectiveness and professionalism of scientific work. The Czech government selected the IMTM project in 2010 as one of the high-priority projects for national biomedical infrastructure and it was recommended that the IMTM act as the national contact point for EATRIS. As a result, the first round of negotiations was launched with EATRIS representatives, which subsequently led to a joint declaration of interest with regard to involving the Czech Republic in the EATRIS network during the implementation phase.

INFRAFRONTIER – Czech Centre for Phenogenomics

One of the most important tasks of biomedical research is to identify the functions performed by human genes. This knowledge is of key importance for the future of molecular medicine and it will significantly influence the development of new diagnostic techniques and therapy methods. Mice, which are genetically very close to humans, are ideal for the modelling of human physiological functions and diseases and also for testing new medications and treatments strategies. For this reason, a worldwide collection of approximately 25,000 mouse models is being established and will be used for the basic study of the role played by each gene. The pan-European INFRAFRONTIER infrastructure (http://www.infrafrontier.eu/) will also participate in this activity with two complementing programmes: 1) "Phenomefrontier" for high-throughput, systemic, and standardised phenotyping (i.e. the characterisation of the influence that individual genes have on a complete physiological organism); and 2) "Archivefrontier" for the cryogenic archival and distribution of models. INFRAFRONTIER brings together prestigious European institutions that are involved with the functional genomics in mouse models. This infrastructure is represented in the Czech Republic by the **Czech Centre for Phenogenomics (CCP)**, which is being developed as a part of the **BIOCEV** centre of excellence and the Institute of Molecular Genetics of the Academy of Sciences of the Czech Republic (IMG). Whilst the **CCP** will be responsible for the BIOCEV phenotyping programme, the Transgenic Unit of the IMG ASCR (which is being transferred under BIOCEV; http://tgunit.img.cas.cz/news.html) has been responsible for the Archivefrontier programme since 2008. The CCP became a **full member** of INFRAFRONTIER in 2009 and the Transgenic Unit of the IMG ASCR (as a part of the CCP) became a part of the EMMA (European Mouse Mutant Archive) network in 2010. EMMA is Europe's most important mouse model archival and distribution network. In addition to its participation in international activities, the CCP will also provide know-how for the gene analyses and models studied at Czech scientific centres. The objective of the INFRAFRONTIER-CCP project is to develop a unique expert centre, which includes all of the complete logistics units that are required for the effective application of functional genomics for creating mutant models, the characterisation and phenotyping of these models, their cryogenic archival and distribution, and the analysis of bioinformatic data. Education and training for PhD students will also be included. The CCP's activities are aimed at gaining an understanding of the fundamentals of the development of human diseases and to identify target genes that are important for the pharmaceutical industry. As the basic characterisation of the function of each individual gene appears to be the most important global task undertaken over the past decade, the implementation of this infrastructure will make it possible to keep up with worldwide developments in the study of gene functions and the discovery of new therapeutic goals.

Euro-BioImaging

The **Euro-BioImaging** consortium (www.eurobioimaging.eu), an **infrastructure for imaging methods**, will provide access to cutting-edge imaging technologies across the entire spectrum of biological and medical applications, starting at the molecular level and up to the patient level. It will be organised as a pan-European distributed large infrastructure. The infrastructure will either be formed as a new facility or some existing facilities will be restructured so that they can provide a significant portion of their capacity to external users.

In terms of methodology, the infrastructure is aimed at first-class light microscopy, correlative light and electron microscopy, and medical imaging. These are methods that have recently started pushing the level of biomedical knowledge forward at an amazing speed. A coordinated infrastructure will be established, which will facilitate the development of the newest imaging technologies and will ensure access to them at the national and European levels. From the long-term perspective, the infrastructure will allow the imaging of biomolecules and the study of their dynamics in their natural environments, i.e. in a living cell or tissue. The outputs will be used in basic research, diagnostics, and medical treatment as well as for the development of new medications. An important part of the infrastructure will consist of coordinated education and training for students and specialised and will include the creation of pan-European MSc. And PhD programmes.

Euro-BioImaging will facilitate the basic concentration of research potential, provide access to new imaging technologies, and assist in the development of a Czech network of first-class imaging methods. For the most part, the Czech part of the infrastructure will be a part of the **BIOCEV Centre**. Other specialised facilities may be distributed elsewhere in the Czech Republic (this will be determined during the preparatory phase). It is expected that primarily specialised facilities for imaging techniques, which are operated by legal entities who are members of the BIOCEV and CEITEC infrastructures, as well as the Institute for Clinical and Experimental Medicine in Prague and Masaryk University will be involved in the Euro-BioImaging project. Providing the Czech scientific community with access to these imaging methods is a strategic necessity, without which the affected fields will not attain sufficient competitive strength. The preparatory phase of the Euro-BioImaging project started in December 2010 and will end in November 2013. The construction phase will follow and is scheduled for 2013-2017. The importance of the Czech node of the infrastructure is evidenced by the fact that the Czech partner is responsible for coordinating the WP 13, the Training work package for the entire European consortium. An additional eight Czech entities are involved in the project as associate partners. After it was approved by the European Commission, the project was officially launched on 1 December 2010. An Advisory Committee for the Czech part of the Euro-BioImaging project was established in order and is in charge of coordinating the project in the Czech Republic.

INSTRUCT

The Czech Infrastructure for Integrated Structural Biology (CIISB) is included in two major products under the RDI OP, specifically the **CEITEC** and **BIOCEV** projects (which will be implemented between 2011 and 2015). The **Central Structural Biology Laboratories** (CSLB) included in the CEITEC project are focused on integrating the tri-dimensional structural information that describes proteins, nucleic acids and their compounds into a functional context with the goal of understanding life-important processes at the cellular level and contributing to the development of new medications and diagnostic instruments for medical research. Structural biology research includes the establishment of a comprehensive infrastructure equipped with unique tools for nuclear magnetic resonance (NMR) spectroscopy and molecular cryo-electron microscopy and tomography, supplemented with laboratories for X-ray diffraction, the study of bimolecular interactions, atomic force microscopy (AFM) a proteomics research. The NMR Spectroscopy Laboratory, which is included in the EAST-NMR and Bio-NMR projects under FP7, are linked to the INSTRUCT project. At this time the laboratory already provides open access to unique instruments that can be used by Czech and European researchers.

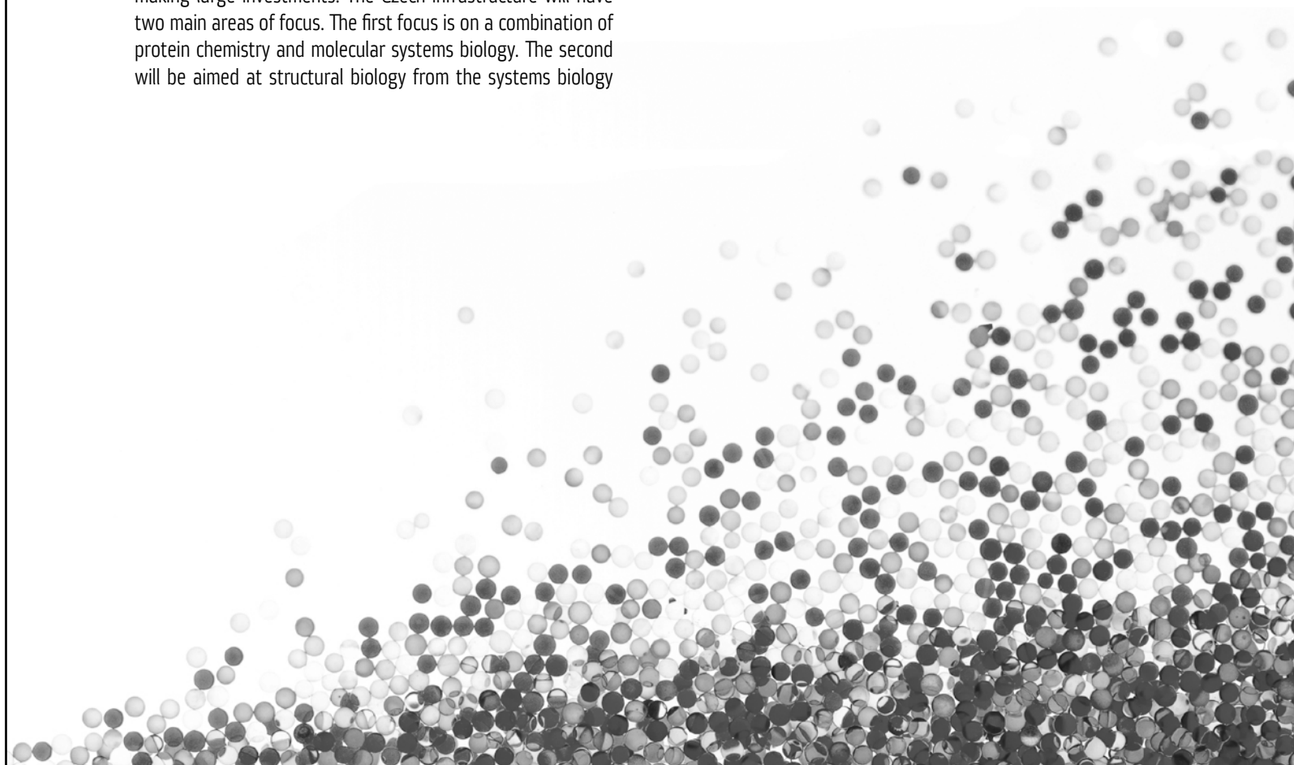
The **Central Laboratories**, which include the required technology for X-ray diffraction, biophysical characterisation, and mass spectrometry, together with the **Structural Biology and Protein Engineering** research programme that is planned under the **BIOCEV** project, will help to ensure a high concentration of know-how in the field of structural biology and will provide open access to users from the entire Czech Republic. The research programme will focus on the study of enzymes for biotechnical and medical applications, the study of the molecular structure of cells and nucleic acids, the inhibition of pathogenic molecules, and the development of biomedications. The researchers from both centres have close ties to the ESFRI INSTRUCT project under FP7. They have the appropriate excellent expertise and will greatly contribute to the education and training of students. It is expected that the CIISCB will function as the National Affiliated Centre for the INSTRUCT project.

CZ-OPENSCREEN

CZ-OPENSCREEN is an infrastructure that introduces an open access platform in the field of chemical biology. The basic foundations for this infrastructure already exist. They will be developed further under the Centre for Chemical Genetics operated by the Institute of Molecular Genetics of the ASCR, and the Institute of Molecular and Translational Medicine of the Faculty of Medicine of Palacký University in Olomouc. The infrastructure is already fully linked to the preparatory phase of the ESFRI project (under FP7). The Institute of Molecular Genetics of the ASCR is a project partner and is leading WP10, the work package for Biology Resources for the preparatory phase of the project for establishing the EU-OPENSCREEN consortium. As compared to commercial platforms, EU-OPENSCREEN will focus on not yet validated molecular targets, signalling pathways, and neglected diseases. The main activity carried out by CZ-OPENSCREEN is the identification of new molecular probes and instruments to be used for basic research and new potential medications to treat critical human illnesses. The activity of the Czech infrastructure will be built on the activities of the centralised screening unit and will provide open access to users from the Czech Republic and abroad. It is intended to be used by researchers from universities and research institutes that have limited or no access to an infrastructure of this kind. The infrastructure will act in cooperation with leading Czech institutes and certain emerging centres (such as BIOCEV, BioMedReg, CEITEC, and ICRC) as well as with other ESFRI infrastructures (Euro- BioImaging, EATRIS, INFRAFRONTIER, INSTRUCT, and ELIXIR). This infrastructure will offer a broad portfolio of services, ranging from the design of tests and high-throughput screening (HTS) to the subsequent validation of results using various in vitro and in vivo models. The infrastructure will also include the National Compound Collection, which will be linked to the collection of compounds included in the European Chemical Biology Database (ECBD). It will also include a copy of the EU-OPENSCREEN screening library, thus providing access to this unique collection of compounds to Czech scientists. Leading Czech chemistry centres, such as the Institute of Organic Chemistry and Biochemistry of the ASCR, the Institute of Chemical Technology in Prague, the Charles University, the Palacký University on Olomouc, the Masaryk University in Brno, will be involved in preparing the compound collection. The Central Database of Screening Results (ChemGenDB), detailed protocols, and information on chemical compounds will be made accessible to the public after a certain protective period. **The project is financed from the Prague Competitiveness Operational Programme (PC OP)** and the Research and Development for Innovation Operational Programme (RDI OP).

Centre for Systems Biology

The foundations for the Centre for Systems Biology were established in Nové Hrady by the Institute of Systems Biology and Ecology of the ASCR. At this time, negotiations are underway to integrate the Nové Hrady campus into the Biology Centre of the ASCR. Once this has been accomplished, the Biology Centre should become the Czech contact point for the European Infrastructure for Systems Biology (**ISBE**), which, once approved by ESFRI, will enter the preparatory phase. As the contact point for the ESFRI ISBE, the Biology Centre will provide Czech scientific institutions with an excellent opportunity to use the European infrastructure together with access to productive technological and knowledge centres (centres of excellence) and planned information repositories, without the necessity of making large investments. The Czech infrastructure will have two main areas of focus. The first focus is on a combination of protein chemistry and molecular systems biology. The second will be aimed at structural biology from the systems biology perspective. The potential of both types of approaches in the application sector can be defined as the influence of molecular systems biology on molecular medicine. Primarily, this Systems Biology Centre wants to provide all users of the ESFRI-ISBE infrastructure as well as users in the Czech Republic with expertise in model organisms (e.g. photosynthetic organisms), the development of technologies associated with these models, the related ecological aspects, the standardisation of methodologies, and the integration of generated data with the development of hardware and software. At the same time, the Centre has the ambition of becoming one the teaching and training structures for the ESFRI-ISBE and to provide educational activities for a new generation of systems biologists.



ECRIN/CZECRIN – National Infrastructure for Academic Clinical Research

The European Clinical Research Infrastructures Network (ECRIN; www.ecrin.org/) is a pan-European infrastructure focused on academic clinical research and focuses on developing interoperable networks of European facilities that comply with the national legal conditions of the applicable member state as well as with the conditions of the European Medicines Agency (EMA) for performing academic clinical trials.

The national infrastructure in the Czech Republic (CZECRIN) was established with open access to eligible entities and is under the leadership of the Masaryk University and the International Clinical Research Centre of the St. Anne's University Hospital in Brno (FNUSA-ICRC). CZECRIN includes a University Module and a Clinical Module. The University Module is responsible for methodological support; coordination and independent monitoring of clinical trials; the collection, archival and analysis of clinical data; and education in the field of clinical testing. Masaryk University has been proposed as the national contact point. The University Module is synergistically complemented with the Clinical Module, which headed by the FNUSA-ICRC and whose key function is to identify the patients who meet the criteria for a clinical trial with special consideration given to less timely diagnoses that require a significant level of cooperation on the part of the healthcare facility. Another function of the Clinical Module is to implement the standards for clinical trials within the Czech legislative context and to perform the clinical trial. Both modules work together to ensure the appropriate interaction with the Czech Republic's regulatory authorities.

Table

Name of the large infrastructure	Brief description	Infrastructure type	Year of completion
Bank of Clinical Samples – BBMRI_CZ	Biobank for clinical tumour samples	National part of ESFRI	Existing
EATRIS/EATRIS-CZ	Translational medicine	National part of ESFRI	2014 – a part of the BIOMEDREG project under the RDI OP
INFRAFRONTIER	Czech centre for phenogenomics	National part of ESFRI	2015 (Archivefrontier has been in existence since 2009) – a part of the BIOCEV major project under the RDI OP
Euro-BioImaging	Imaging methods centre	National part of ESFRI	Included in the BIOCEV and CEITEC major projects under the RDI OP
INSTRUCT	Czech infrastructure for integrated structural biology	National part of ESFRI	součást velkých projektů z OP VaVpI - BIOCEV a CEITEC
CZ-OPENSCREEN	Chemical biology platform	National part of ESFRI	2013 – a project under the Prague Competitiveness OP
Centre for Systems Biology	Structural biology centre	National	Existing
ECRIN/CZECRIN	National infrastructure for academic clinical research	National	Partially falls under a major project for the RDI OP

5.4 Promising Projects

ELIXIR_CZ (formerly CZ_BIOINFO)

The ELIXIR_CZ project was created for the purpose of establishing a national bioinformatics infrastructure. Its primary mission is to ensure full integration into the European ELIXIR bioinformatics infrastructure and this goal defines the profile, focus and structure of this project to a significant degree.

ELIXIR (www.elixir-europe.org) is a European infrastructure project for the sustainable development of bioinformatics. It was established as a result of an analysis that was performed with regard to the quantity and flow of biological data in Europe. The volume of this data is growing at an exponential rate and is becoming unmanageable at the local level. Currently there are no standardised data formats or software applications. The hardware and communication infrastructure does not have sufficient transmission capacity to handle the expected increase in data volume. The existing methods used for storing and distributing biological data make it impossible to ensure its sustainability and the continuity of its development and maintenance. At this time, bioinformatics projects in the Czech Republic and at the European level are based on grant financing, which is time-limited and, from the medium- and long-term perspectives, precludes the sustainability of data sources. In order to keep pace with global developments in this field, it is of the utmost importance to ensure the sustainability of data sources, the communications infrastructure, and coordination at the European level, which is based on the ongoing and long-term financing for bioinformatic projects. The importance of bioinformatics in the biomedical disciplines is growing at a rapid rate together with the increase in the volume of data that is produced. A biometrics solution within the framework of the European structures is one of the highest priorities in the field of biomedical research.

The organisational structure for the ELIXIR project is based, firstly, at the national level, which will ensure the coordination of small local projects (i.e. the national infrastructure) in a way that corresponds to the defined standards. Secondly, it is defined at the level of individual international projects, such as projects dealing with extensive databases and distribution channels for data sources. It is expected that high-capacity independent academic communication networks will be created in order to satisfy requirements.

The majority of bioinformatics activities in the Czech Republic are brought together and presented by the professional Czech Society for Biochemistry and Molecular Biology (CSBMB) of the Free and Open Bioinformatics Association (FOBIA), which organises conferences, seminars and lectures, provides support to individuals interested in this discipline, and externally represents the bioinformatics community. It includes both academic facilities as well as the facilities operated by universities.

The Czech national node of ELIXIR has been proposed as an independent laboratory under the Institute of Organic Chemistry and Biochemisty of the ASCR. (A preliminary agreement for hosting the laboratory has been approved). This laboratory will be responsible for coordinating all projects associated with the national bioinformatics infrastructure. In particular it will be responsible for the standardisation of data and for the storage and distribution of locally developed data and software sources. It will also ensure communication and coordination with other infrastructure projects (e.g. BIOMEDREG, EATRIS, INFRAFRONTIER, OPENSCREEN, and INSTRUCT). In addition, ELIXIR_CZ will be the exclusive Czech partner for coordination within ELIXIR and will ensure communications within the EU as well as the transfer and implementation of international standards. In cooperation with other entities, it will ensure the development of the communications infrastructure and its connectivity to European sources and networks. The coordinators of this project will represent the Czech side in WP3, the work package for Coordination and Participation (the Bioinformatics Communities Committee) and will be directly involved in defining the conceptual framework for this infrastructure.

National Centre for Medical Genomics (NCMG)

Genomics is a branch of biology that performs complex genome analysis. At this time, when it is almost standard to perform an analysis of the complete human genome, genomics is gradually starting to dominate the entire field of biomedical research. It can be expected that genomic processes will successfully identify the genetic causes of a number of rare and also frequent population-based diseases, thus helping to gain an understanding of the basic biological mechanisms that lead to the rise of certain disorders and which affect the course of these disorders. These skills and knowledge, combined with accessibility to modern analytical instruments, will establish a basis that can be used to perform a qualified analysis of an individual's genetic information, which can subsequently be used for accurate and timely diagnosis, prevention, and targeted treatment in all branches of medicine. As a result, the introduction and application of medical genomic methods will significantly influence the quality of biomedical research and consequently the quality of the Czech Republic's healthcare system.

The rapid development of genomics, together with the instrumental, intellectual and financial demands associated with this field, has thus far made it impossible to expand its laboratory environment. This has led to the necessity of establishing highly specialised centres in which instruments and equipment, which are demanding from the perspective of cost and staffing, are concentrated. The centres provide an appropriate computer environment and the specialists that can ensure the qualified use of the instruments, perform expert bioinformatic analyses, securely store data, rationally plan experiments, and guarantee the methodological and application development of the field. As a result of awareness about the important role that genomics plays in the development of the medical, natural, and social sciences and on the basis of the impact that wide-range of accessibility to genetic information will have on society, a number of genomic centres have been established around the world in the past few years and they are supported directly at the national governmental level. Within this context and in comparison with its neighbours and other developed countries of the world, thus far genomics has not been developed and adequately supported in a focused manner in the Czech Republic. The National Centre for Medical Genomics (NCMG) intends to respond to these challenges.

The purpose behind the existence of the NCMD is to concentrate the expensive and otherwise demanding instruments required for genomic analysis, to develop a common computer infrastructure and data warehouses, and to train the appropriate specialists, thus ensuring the qualified use of the instruments and providing the expertise required to plan experiments and bioinformatic analyses, to interpret genomic data, and to ensure the long-term secure archival of the results. The most important objective is to ensure the maximum possible expert level of genomics in the Czech Republic and to enable this field to be used by the broadest possible range of medical fields and scientific teams in the Czech Republic and abroad.

The NCMD was established as a joint association of teams that have been involved in medical genomics over the long-term and includes teams from the First Faculty of Medicine of the Charles University and the General Teaching Hospital in Prague, the Faculty of Medicine of Masaryk University and the Faculty Hospital in Brno, the Central European Institute of Technology (CEITEC) operated by the Masaryk University; and the Second Faculty of Medicine of Charles University and the University Hospital in Motol. Certain facilities already have modern instruments used for analysing the human genome and they provide the appropriate expertise to a number of other facilities in the Czech Republic and abroad. They are also involved in a number of international projects and provide each other with mutual cooperation.

6 Informatics/ e-Infrastructure

6.1 Current Status

Top-quality information technologies with an adequate capacity and the proper configuration are essential for modern science. No scientific team can imagine working without a solid IT environment anymore. However, the IT environments that are required have many features in common without regard to the specific scientific disciplines that they serve. These common IT characteristics make up the e-infrastructure, the development and operation of which require special attention.

The most important component of an e-infrastructure is a stable high-speed communication network, which makes it possible to transfer large volumes of scientific data, allows the creation of private high-capacity data circuits for interconnecting large scientific infrastructures, has a shared authentication infrastructure, provides an environment for collaboration, etc. The next layer consists of the environment for storing data, for intelligent data distribution and for data processing, including a corresponding level of computing power and the required coordination, thus creating an environment which makes it possible to solve even the most complex experiments in silico. As a result, e-infrastructures consist of supercomputer centres providing cutting-edge performance, as well as of computing and storage grids, which have the primary task of interconnecting the capacities installed in individual research organisations into a distributed, yet compact unit. Most recently cloud computing solutions have also come into play. They offer the maximum possible level of flexibility and are an excellent complement to supercomputer and grid resources.

A comprehensive e-infrastructure cannot be developed centrally or only within one organisation, as that would limit the potential offered by its distributed nature and its use as a tool for widespread cooperation. Likewise, an e-infrastructure cannot serve only or a few small specific areas. Its dominant supportive (infrastructural) nature must be integrally supplemented through further research and development activities, which may be minimal with regard to the budget, but help to ensure the high quality and unique parameters of the services that are provided, as well as the characteristics that are not yet commercially available from the competitors.

At this time the Czech Republic's largest infrastructure is operated by the CESNET Association in the form of the CESNET2 national research and development network. This is a state-of-the-art communication infrastructure, at this time consisting of the beginning stages of a computing and storage grid (according to the National Grid Initiative) and a number of other advanced services (such as centralised authentication, education roaming, and a videoconferencing infrastructure). CESNET is intensively involved in its further development.

6.2 SWOT Analysis

Strengths

- Significant potential exists for utilising an e-infrastructure to increase the effectiveness and competitiveness of research teams (the sharing of information, knowledge, unique equipment, and experimental results; and more effective communication);
- The most important component of the e-infrastructure (communication) is of a world-class standard in the Czech Republic and is provided by the CESNET Association;
- The distributed computing and storage infrastructure (grid) is of a very high international standard from the organisational point of view although the capacity is limited. It is provided by the CESNET Association; and
- Both the network and the grid have long been fully integrated in European infrastructure projects (the GN3, EGI, and EMI projects).

Weaknesses

- Comprehensive e-infrastructures as described in the strategic ESFRI and e-IRG documents have not yet been defined in the CR and no coordinated support (financial or conceptual) is provided for them. In addition, education in the field of scientific computing is lacking;
- There is insufficient computing and storage capacity for the research community. Supercomputer resources are non-existent in the CR, even though the developments that have taken place in all scientific disciplines and the high level of innovation in the industry sector require the ability to perform modelling and computer experiments as well as long-term storage capacity for large data files;
- The knowledge required for the operation and administration of distributed and supercomputer systems and large data storage facilities is distributed unevenly throughout the CR. There are no clearly defined programmes for training the specialists required to ensure the truly innovative utilisation of the resources of comprehensive e-infrastructures; and
- The opportunities offered by supercomputer technologies and large distributed computing and storage systems are not sufficiently used for teaching the scientific and technical disciplines, which leads to an undervaluation and inadequate use of the potential offered by computing experiments, modelling, and simulation.

Opportunities

- The implementation of the recommended projects will make it possible to establish a comprehensive e-infrastructure for the research and academic community in the Czech Republic. At this time the Czech Republic does not have an infrastructure that provides all basic services (i.e. network, data storage, distributed and flexible (cloud) computing services, and supercomputer centres). The surveys that have been carried out in relation to establishing an e-infrastructure clearly show that the scientific community needs and demands these services;
- The recommended projects complement each other and have the potential to cover all aspects of a modern comprehensive e-infrastructure. Their implementation will lead to a synergistic effect (new levels of collaboration, the improved utilisation of capacities, a wider range of offered services, etc.);
- The implementation of these recommendations will result in the simultaneous provision of support to first-class scientific teams and the installation of major parts of the distributed e-infrastructure in the regions;
- The establishment of a high-quality e-infrastructure will significantly contribute towards the stabilisation of researchers in all of the scientific disciplines and will create the required conditions for further personal growth within the Czech scientific community;
- In the case of distributed computing capacity, a high level of autonomy will be retained (most of the equipment will be owned and administered by individual organisations), while the central coordination and integration into the grid will facilitate inter-institutional and interdisciplinary collaboration at the national and international levels;
- Centrally established supercomputer centres (truly corresponding to the nature of a "centre") will also be appropriately integrated into the national system, although with a specific role; and

- The integration of centres into university environments will make it possible to use the installed capacity for training new experts in a wide variety scientific and technical branches and professions.

Threats

- Insufficient financing is provided for an e-infrastructure due to an underestimation of the adequate computing and storage capacity required by Czech academic and industrial research;
- The uncoordinated acquisition and, in particular, the uncoordinated operation of information technologies (transmission, storage and computing capacities), which, in addition do not have any links to the national e-infrastructure strategy, result in suboptimal utilisation, undesirable duplication, and a lack of available capacity in the locations where it is truly required;
- The grid component of the e-infrastructure is based on interconnecting the computing and storage capacities of individual entities (RDI projects, ESFRI, universities, and research institutions). The scope and volume of available resources depends on the willingness of these institutions to share their resources;
- The established e-infrastructure may become unsustainable due to a lack of financing for its operation;
- There is a risk of the possible loss of accumulated know-how and of the CR's established international reputation due to insufficient support for the national part of international e-infrastructures (GN3, EGI, and PRACE).

Proposed Solution

A comprehensively conceived large e-infrastructure consists of four basic parts, specifically (1) a computer network; (2) computing capacity; (3) storage capacity; and (4) horizontal activities and associated services.

Network Infrastructure and Associated Services

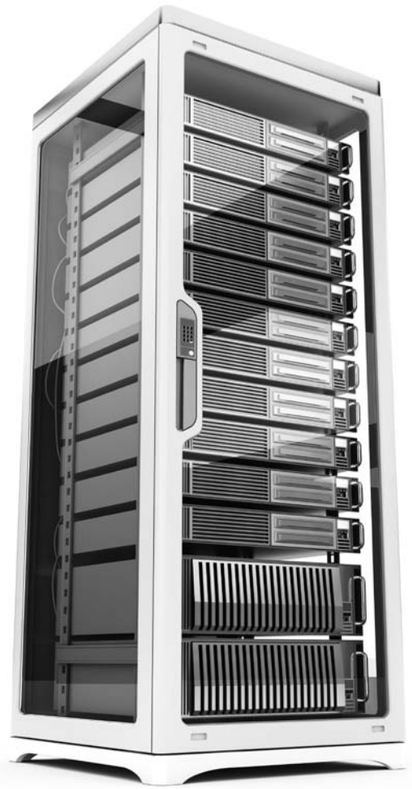
The main building block for the network part of the e-infrastructure consists of the actual physical network infrastructure implemented using a sophisticated optical transmission system and data transfer technologies that use the Internet Protocol (IP). An optical infrastructure offers a number of options for operationally modifying the topology and configuration of the transmission channels to meet actual requirements (advanced DWDM technology), for providing end-to-end high-capacity transmission circuits, and other features. The IP layer of the network provides data transport services with the best possible parameters and a wide range of add-on functionality, such as virtual private data circuits, optimised real-time transmission of large volumes of data, multi-point data distribution, and others. The network is connected to the Internet and also has a high-speed connection to the European GÉANT network, thus providing a very high-quality connection to national and European research infrastructures and even to research infrastructures in other parts of the world.

Computing Infrastructure and Associated Services

The computing infrastructure consists of a supercomputer centre and a distributed grid computing environment. This combination, in conjunction with the use of shared horizontal services, minimises the overhead associated with using multiple centres, whilst still allowing independent use as well as the ability to synchronise tasks. Thanks to the centralised coordination provided according to the National Grid Initiative, the computing and associated storage capacities of the individual centres, institutions, and research teams are connected to this environment. An integral part consists of the distributed administration of access rights, which makes it possible for the centres to use a common set of tools, protocols and interfaces in order to determine who is authorised to use the provided resources. Cloud (virtual) resources, which allow highly flexible administration that can be performed directly by the end users, are gradually being integrated. In order for this model to function properly, coordination at the national level is of the utmost importance. The provision of sufficient available computing capacity is also vital, firstly at the level of the supercomputer centre and secondly, through the cloud interface that is integrated into the national grid. The ability to participate in international collaboration is ensured through the PRACE project for the supercomputer centre as well as on the basis of participation in the EGI InSPIRE project and other projects associated with the grid environment.

Storage Infrastructure and Associated Services

The effective use of the data produced by just about all scientific disciplines is impossible unless the data is shared and only if the ability exists to control access according to the nature and age of the data. For this reason, the e-infrastructure must include data repositories with sufficient capacity that can be used both for the long-term storage of data and which ensure that the data is retained (e.g. the results from experiments) as well as a part of the computing environment that is used for extensively working with data and often serving as a generator of additional derived data (e.g. the output from processing experimental results, simulation results, etc.). The data is made accessible using various protocols. Users have the ability to manage access to the data with very varying levels of granularity. The distributed nature of the data repositories is advantageous, as it makes it possible to distribute the load and, at the same time, it guarantees data retention and access to the data even in the event of an unexpected catastrophe that could affect a specific centre (or repository). Data custodianship is also important and includes tasks such as moving data to the appropriate archives and deleting data that is no longer needed.



Horizontal Services

Security services are essential, both with regard to identifying users and managing access, as well as in relation to monitoring and responding to security incidents. All of the other parts of the e-infrastructure share the need for these services. The environment that is provided for collaboration is also becoming more and more important (i.e. videoconferencing, IP telephony, etc.). In this case, not only the network component is important, but also the overall integration with the computing and storage environments, i.e. the sharing of calculations, data and information. As a result, it also impacts all of the aforementioned areas and thus meets the definition of a horizontal service.

6.3 High-Priority Projects

CESNET Large Infrastructure – the Czech partner for GÉANT and EGI.eu

The aim of the CESNET Large Infrastructure project (http://www.cesnet.cz) is to develop the foundations for a Czech e-infrastructure that will be used for research, development and innovation according to the proposed solution described above. This will facilitate the Czech Republic's full involvement in the European Research Area and its integration into the pan-European infrastructures. As far as the network infrastructure is concerned, the goal is to ensure sufficient transmission band width, in particular with regard to the expected creation of research centres such as IT4Innovations, BIOCEV, and CEITEC, as well as to allow the barrier-free involvement of Czech scientists in international research projects. The CESNET national network will be guaranteed to have the required parameters thanks to its connection to the GÉANT European network and its participation in the GN3 project.

In the case of the computing infrastructure, CESNET will assume the role of coordinator for the National Grid Initiative (NGI), which will ensure that all important computing and storage capacities are connected and shared within the framework of international collaboration in all scientific disciplines. Thanks to the EGI.eu organisation and its involvement in the EGI InSPIRE project, the Czech NGI will be integrated into the European Grid Initiative (EGI) infrastructure.

The project also includes horizontal services, specifically security, management of access to resources, and tools that will facilitate the effective collaboration of the distributed teams.

The final e-infrastructure that is established will serve not only as a transparent shared communication environment for individuals and entities involved in research, development and innovation across all of the sectors in the Czech Republic, but also as a testing and development environment for new information and communication technology systems and applications. CESNET will also connect both other national e-infrastructure centres for the use of researchers throughout the Czech Republic.

The associated **eIGeR** project, which aims to modernise the network, grid, and other infrastructure components, was approved for financing under Priority Axis 3 of the RDI OP.

IT4Innovations – Czech partner for the PRACE project

The global objective of the IT4Innovations project (http://www.it4i.eu) is to establish a Czech national centre of excellence for top quality information technology research. The project includes the establishment of a research environment, including the required infrastructure, designed specifically for the research and development of supercomputing methods and with special emphasis placed on its usability within the applied sciences and for the development of an information society. The project aims to build onto a foundation consisting of a high-performance infrastructure (at the level of the TOP 100 supercomputers) and to construct a broad portfolio of services, starting with the research and development of new methods and support for parallel algorithms, including the design and implementation of computationally demanding tasks of a multidisciplinary nature, and ending with the provision of the required computing capacity. In total, performance at a level of approximately 32,000 computing cores and 8 PB of storage capacity will be made available. The Centre will provide open access to approximately 30% of the computing power to other research institutions, primarily to ones based in the Czech Republic. Approximately 20% of the capacity will be reserved for projects that are included in the Roadmap for large infrastructures. Based on the requirements of the Ministry of Education, Youth and Sports, the required capacity will be provided to the CzechGlobe, RECAMO, and AdMaS research infrastructure projects.

The VŠB – Technical University in Ostrava (VŠB-TUO), which is the main partner of the IT4Innovations Centre project, will also act as the Czech node of the Partnership for Advanced Computing in Europe (PRACE) infrastructure. At this time, PRACE already ensures access to world-class supercomputers throughout Europe. As a part of its activities in PRACE and as a member of the PRACE Research Infrastructure Consortium, VŠB-TUO will provide consultancy services, education, and training aimed at increasing the use of supercomputer technologies in the Czech research environment; provide information on the options available for using the PRACE infrastructure and the computing resources provided by VŠB-TUO; and act as the coordinator for high-performance computing activities in the Czech Republic. A part of the IT4Innovations computing resources will be available for the use of interested parties from other European countries in relation to their involvement in PRACE.

At this time, the IT4Innovations project has been approved by the Ministry of Education, Youth and Sports. As it is a major project, it is being evaluated by the European Commission.

CERIT-SC

The CERIT Scientific Cloud Centre (http://www.cerit-sc.cz) will be a Czech national centre that provides flexible computing and storage capacity and all associated services. The Centre will also perform research and development related to flexible infrastructures and will participate in the research activities of its users. CERIT-SC was established through the transformation of the Brno Supercomputing Centre (BSC), which is operated by the Masaryk University's Institute of Computer Science. It has been designed to be the most important and most productive node of the national grid infrastructure and will also be the most important Czech node in the international European Grid Initiative (EGI) infrastructure. The CERIT-SC Centre will offer the capacity of 2,500 computing cores and 3 PD of storage. This virtual computing and storage capacity, which will be made accessible using a combination of cloud and grid environments, will be a unique facility in the Czech Republic, in the Central European region and possible within an even broader area and will provide an opportunity to use e-infrastructures in entirely new ways. CERIT-SC will be involved in developing the EGI infrastructure and, within the framework of collaborative efforts aimed at the optimal use of its own and other resources in the national grid infrastructure, will also be involved in a number of RDI OP and ESFRI projects. As a result, the Centre is an integral part of the national e-infrastructure from the perspective of the strategic e-IRG documents, that is to say a complex system of interlinked network, computing and storage capacities and associated services for the Czech Republic's research community and the mechanism that ensures the CR's integration into the European Research Area. Based on its focus and the array of services that it offers, the CERIT-SC complements the two other components of the national e-infrastructure – the CESNET Association and the IT4Innovations supercomputer centre.

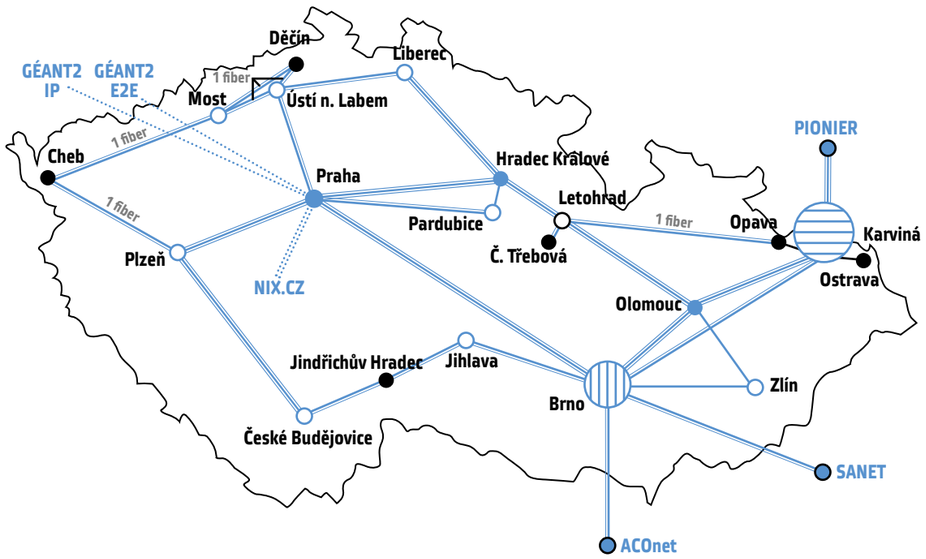
All of Centre's capacities will be made available on the basis of the open access principle and will be provided free of charge through the funding provided for supporting large national infrastructures and other sources of financing, in particular resources provided for specific projects. The Centre has already entered into an agreement for cooperation and the effective use of its resources with emerging centres of excellence, such as CzechGlobe, CEITEC, BIOCEV, RECAMO, and AdMaS. Through these other centres, CERIT-SC has established links with other large infrastructure and important ESFRI projects (e.g. BBMRI, Euro-BioImaging, and ELIXIR) in which the Czech Republic is involved.

The CERIT-SC project was approved for financing under Priority Axis 3 of the RDI OP.

Table

Name of the large infrastructure	Brief description	Infrastructure type	Year of completion
CESNET	Communication e-Infrastructure and National Grid Infrastructure	Czech part of the European projects (GÉANT, EGI)	Existing; renovation – 2015
CE IT4Innovations	Supercomputer centre	Czech part of the European project (PRACE)	New; completion – 2014
CERIT – SC	Flexible cloud computing centre and the main node of the national grid	Czech part with a direct connection to EGI	Existing prototype expanded under the RDI OP; renovation – 2014

The following image shows the proposed distribution for the individual components of the e-infrastructure in the Czech Republic.

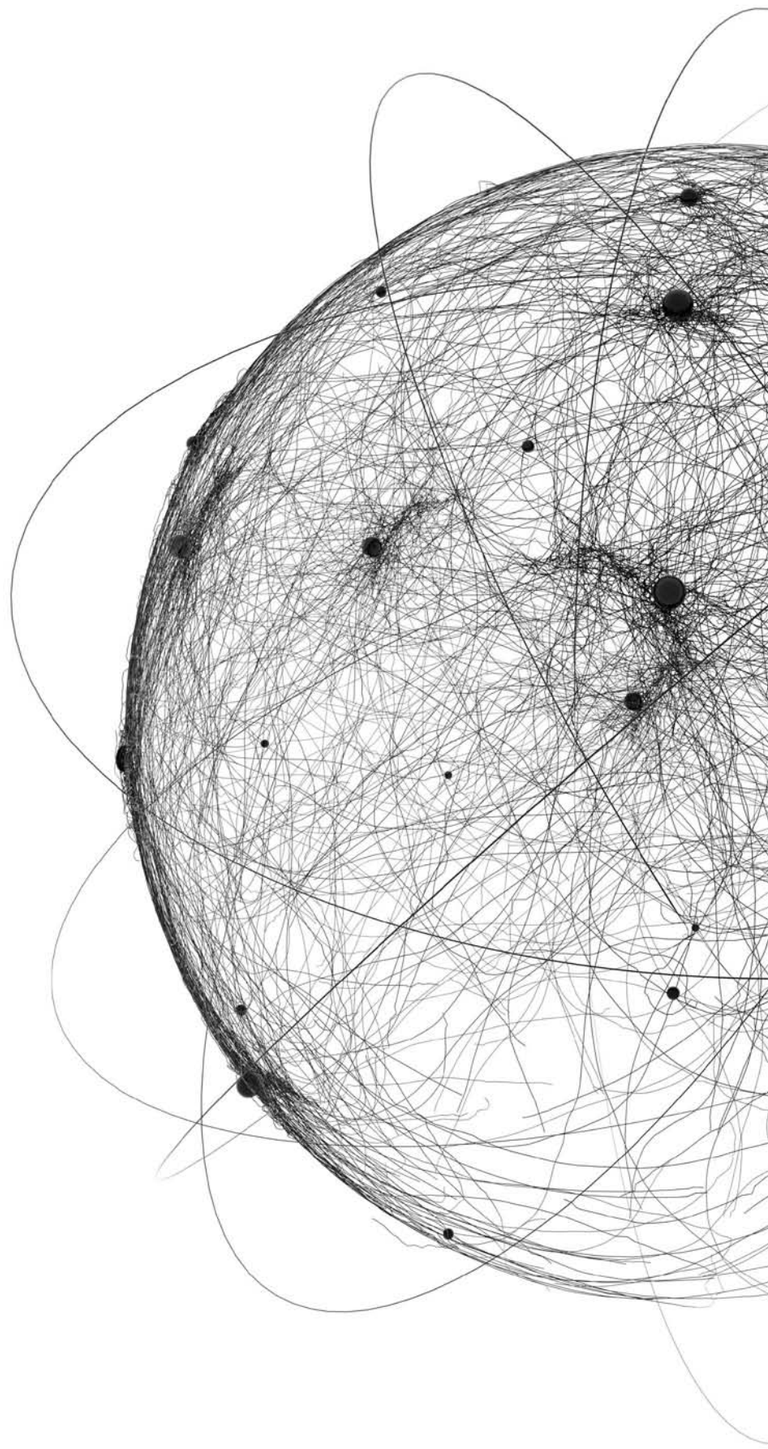


Supercomputer IT4I

CERIT-SC

- P core router
- PE router
- CE switch
- CBF node
- ROADM OIN

- DWDM + ROADM
- CLA DWDM
- 10GE LAN PHY
- 1 Gbps



Annex

part C

1. List of Acronyms and Abbreviations

A

ALICE – A Large Ion Collider Experiment
ALICE is an experiment involving the construction of a specialised heavy-ion detector for the identification of unique physical properties of nucleus-nucleus interactions at the energies that can be delivered to ions by the Large Hadron Collider accelerator.

ATLAS – A Toroidal LHC ApparatuS
ATLAS is a detector for the LHC accelerator weighing 7,000 tonnes and placed 100 metres below ground. It is a multifunctional detector capable of detecting, amongst other things, Higgs bosons. The length of the equipment is 44 metres; the magnetic fields of the coil deflect charged particles of 2 T.

AURORA BOREALIS – The European Polar Research Icebreaker (research of polar oceans in the Arctic region)

B

BBMRI – European Biobanking and Biomolecular Resources Research Infrastructure

BHCL – Bibliography of the History of the Czech Lands

BIOCEV – Biotech & Biomed Research Centre (Biotechnological and biomedical centre of the Academy of Sciences of the Czech Republic)
The project was submitted under the OP RDI. The aim of this project is to establish an excellent biotechnological and biomedical centre.

BIOMEDREG – Biomedicine pro Regional Development and Human Resources
This project uses biomedical disciplines to focus on research, development and innovation in biotechnologies and advanced materials and technology.

BMS – Biomedical Sciences

C

CANAM – Centre of Accelerators and Nuclear Analytical Methods
The Institute of Nuclear Physics of the Academy of Sciences of the Czech Republic, a public research institution, is the Czech Republic's leading operator of particle accelerators and equipment for performing analysis using nuclear methods.

CCP – Czech Centre for Phenogenomics
The Centre will focus on developing and analysing animal models. The obtained results will subsequently be used to help gain an understanding of the fundamental reasons behind the development of human diseases.

CEITEC – Central European Institute of Technology
This project aims to increase regional and national competitiveness through creating a sustainable "engine" for generating regional innovative capacity in the fields of the biosciences, biomedicine and advanced materials and technologies.

CERGE-EI – Centre for Economic Research and Graduate Education - Economics Institute
This foundation was established with the aim of obtaining financing to support economic education not only in the Czech Republic, but throughout all of Central and Eastern Europe. As is indicated by its name, the CERGE-EI Foundation is closely affiliated with the Charles University Centre for Economic Research and Graduate Education and the Economics Institute of the Academy of Sciences of the Czech Republic.

CERIT-SC – The CERIT Scientific Cloud Centre was established as a national centre in Brno, which provides flexible storage capacity and computing resources.

CERN – Conseil Européen pour la Recherche Nucléaire (European Organisation for Nuclear Research)

CERN is the world's most extensive research centre for particle physics.

CESNET – Czech Education and Scientific NETwork (the Czech Republic's nationwide computer network for research, development and education)

CESSDA – Council of European Social Science Data Archives (an umbrella organisation for social science data archives across Europe)

CLARIN – Common Language Resources and Technology
This is a virtual infrastructure, which aims to facilitate access to linguistic sources and technologies and to overcome the fragmentation that currently exists.

CNC – Czech National Corpus

CVVOZE – Centre for Research and Utilisation of Renewable Energy
CVVOZE is a new research centre involved in performing research for the effective and sustainable use of energy sources.

CzechCOS – Czech Carbon Observation System
CzechCOS is the national centre for studying the impact of global climate change and serves to complement ESFRI infrastructures such as ICOS, EUFAR and LIFEWATCH. The centre's large infrastructure provides an environment in which observational research can be performed at the level of individual types of ecosystems and biodiversity in the Czech Republic.

D

DWDM – Dense Wavelength Division Multiplexing
DWDM is a technology using amplifiers, which need to be present in the signal path due to counteract losses and the gradual "weakening" of the signal.

E

EATRIS – European Advanced Translational Research Infrastructure in Medicine

ECBD – European Chemical Biology Database (a collection and database of compounds)

ECRIN – European Clinical Research Infrastructure Network (a pan-European infrastructure for clinical research and biotherapy)

EGEE – Enabling Grids for E-sciencE
EGEE is a functional pan-European large grid infrastructure, which makes it possible for the wider European scientific community to use computing resources that are currently unsurpassed at the European level.

EGI – European Grid Initiative (EGI) Design Study – European Grid Infrastructure
This initiative represents the effort to establish a permanently sustainable grid infrastructure in Europe. Depending on the needs and requirements of the research community, the EGI DS project is expected to facilitate another qualitative leap in large infrastructures that support scientific research in the European Research Area (ERA). The National Grid Initiatives (NGIs), which ensure the operation of grid infrastructures in individual countries, are the basic building blocks for the European Grid Initiative (EGI). The EGI will interconnect the existing NGIs and will actively support the establishment of new NGIs. The aim of the EGI Design Study (EGI_DS) is to evaluate the coordination efforts, to identify the processes and mechanisms required for establishing the EGI, to define the structure of eligible institutions, and to initiate the establishment of an EGI organisation. The EGI Design Study project is financed from the EU's Seventh Framework Programme.

(e-IRG) e-Infrastructure Reflection Group
The Group's main objective is to support the creation of a political, technological and administrative framework for the simple and economical shared use of distributed electronic resources throughout Europe. Special attention is paid to grid calculations, data storage and networks.

ELETTRA
ELETTRA is a major international multidisciplinary Synchrotron Light Laboratory in Trieste, which provides researchers with the ability to use synchrotron radiation in basic and applied research.

ELI – Extreme Light Infrastructure – a project for the world's most powerful laser

EMBL – European Molecular Beam Laboratory – a laboratory situated near the ILL and ESRF, which allows the preparation

and characterisation of biological material samples intended for microscopic examination using ILL and ESRF equipment.

ENVI – Environmental Sciences

ERIC – European Research Infrastructure Consortium
ERIC is a new legal framework. Any state that wishes to have an ERIC research infrastructure within its territory is required to state in its application that this infrastructure will be acknowledged as an international organisation from the time of its establishment. As a result, the consortium will be exempt from VAT and consumer tax.

ESA – European Space Agency
ESA is currently the second largest space agency worldwide.

ESFRI – European Roadmap for Research Infrastructures – Europe's strategic forum for research infrastructure

ESO – European Southern Observatory – formally the European Organisation for Astronomical Research in the Southern Hemisphere

ESRF – European Synchrotron Radiation Facility – a pan-European facility for multidisciplinary research in the field of advanced materials.

ESRF Upgrade – an ESFRI project focused on updating the key ESRF facilities

ESS – European Social Survey
The ESS programme focuses on the continuous collection of data on the basic indicators required in order to explain the interaction between institutions in an ever-changing Europe.

ESSS – European Spallation Source Scandinavia
The ESSS is a pan-European facility using neutron beams for multidisciplinary research in the field of advanced materials.

EU–OPENSCREEN – European Infrastructure of Open Screening Platforms
This initiative integrates high-throughput screening platforms, chemical libraries, chemical resources for hit discovery and optimisation, bioinformatics and cheminformatics support, and a database containing screening results, assay protocols, and chemical information.

EUFAR – European Facility for Airborne Research
This initiative is supported by the European Commission. The project's main objective is to bring together methods, technology and experts in aviation research and to use this integration for remote sensing in the environmental sciences and other Earth sciences.

EUMODIC – The European Mouse Disease Clinic
EUMODIC's task will consist of performing the primary phenotype assessment of up to 650 mice. Lines displaying interesting phenotypes will be subject to further research.

EUMORPHIA - European Union Mouse Research for Public Health and Industrial Applications
This large project originally involved the cooperation of eighteen research centres from eight European countries. The project was funded between 2002 and 2006 under the EU's Fifth Framework Programme. The primary focus of the project was to ensure cooperation amongst the many European centres involved in mouse genome research with the aim of understanding the mouse genome to an extent that could help increase the understanding of human molecular psychology and pathology.

ERA – European Research Area

F

FAIR – Facility for Antiproton and Ion Research

FP6 – Sixth Framework Programme

FP7 – Seventh Framework Programme

G

GÉANT (Gigabit European Advanced Network Technology)
GÉANT is a pan-European hybrid computer network that provides a high-performance infrastructure for high-speed IP connections between universities and research organisations throughout Europe.

GN3 – GÉANT Network 3
The main characteristic of this project is its focus on creating and providing advanced information and communication services to end users in a multi-domain environment above a hybrid network infrastructure.

GSI – Helmholtz Centre for Heavy Ion Research, located in Darmstadt, Germany

GZK – Greisen-Zatsepin-Kuzmin
GZK refers to a theoretical upper limit on the energy of cosmic radiation. The limit was independently computed in 1966 by Kenneth Greisen, Vadim Kuzmin, and Georgiy Zatsepin based on the anticipated interactions between cosmic rays and the cosmic microwave background photons.

H

HiPER – European High Power laser Energy Research facility
The facility focuses on demonstrating the feasibility of using laser driven fusion as a future energy source.

I

ICOS – Integrated Carbon Observation System (an ecosystem monitoring network)

ICRC – International Clinical Research Centre

ICT – Institute of Chemical Technology in Prague

IG – Institute of Geophysics of the Academy of Sciences of the Czech Republic

ILL – Institut Laue-Langevin (Max von Laue and Paul Langevin Institute)
The ILL is a pan-European institute, which operates the world's most intense stationary neutron source. Forty unique measuring facilities, which use neutron beams to perform modern experimental research in various scientific fields, are connected to this source.

ILL20/20 – an ESFRI project focused on implementing a major upgrade of key ILL instruments and equipment

IMG – Institute of Molecular Genetics of the Academy of Sciences of the Czech Republic

INEF – Innovation for Efficiency and the Environment
This initiative involves a research and development centre in the field of classic energy.

INFRAFRONTIER
INFRAFRONTIER is the European infrastructure for phenotyping and archiving of model mammalian genomes.

INGO – Inter Non-Governmental Organization
The aim of the INGO programme is to support membership opportunities for research institutions in international non-governmental organisations, which are focused on research and its support.

IOCB – Institute of Organic Chemistry and Biochemisty of the Academy of Sciences of the Czech Republic

IP – Institute of Physiology of the Academy of Sciences of the Czech Republic

IPE – Institute of Physics of the Earth
The institute is the geo-science facility of the Masaryk University's Faculty of Science in Brno.

IS ASCR – Institute of Sociology of the Academy of Sciences of the Czech Republic

J

JHR – Jules Horowitz Reactor
This single-sited infrastructure will ensure the extensive reconstruction of a research reactor. It is located in Cadarache, France.

L

LIFEWATCH
LIFEWATCH is an e-infrastructure focusing on all aspects of research involving the protection, management and measurement of changes in biodiversity.

LINDAT/CLARIN
LINDAT/CLARIN is the Czech node of the international CLARIN network for sharing linguistic data and technologies.

LNSM – Laboratory for Nano-Structured Materials
This laboratory is an essential facility for the experimental study of an entire range of quantum relativistic phenomena in solid state physics and for studying the properties of microelectronic components with dimensions of less than 100 nanometres.

LSM/JOULE – Laboratoire Souterrain de Modane/JOint Underground Laboratory in Europe
This project, which is based in France, covers a significant part of contemporary physics, with activities carried out in underground laboratories.

M

MLTL – Magnetism and Low Temperature Laboratories
These laboratories, operated by the Charles University Faculty of Mathematics and Physics in cooperation with the Institute of Physics of the Academy of Sciences of the Czech Republic, provide the wide scientific community with the measurement of physical parameters of materials at multi-extreme conditions (low temperatures, strong magnetic fields and high pressures).

N

NASA – National Aeronautics and Space Administration
NASA is the United States government agency responsible for the American space programme and general aviation research.

NMI3 – Integrated Infrastructure Initiative for Neutron Scattering and Muon Spectroscopy

NUTS 2 – Nomenclature des Unités territoriales statistique (Nomenclature of Units for Territorial Statistics)
NUTS 2 refers to the territorial units that have been defined at Level 2 (the regional level) for statistical purposes .

O

ORFEUS – Observatories and Research Facilities for European Seismology – a European seismological centre located in the Netherlands

P

PC OP – Operational Programme Prague – Competitiveness

PALS – Prague Asterix Laser System
PALS refers to a research centre that was established as a joint facility of the Institute of Physics of the Czech Academy of Sciences and the Institute of Plasma Physics of the Academy of Sciences of the Czech Republic. It was conceived as a user laboratory that provides a base for experimental research associated with high-performance lasers and laser-produced plasma. The centre was made available to external users in September 2000.

Pierre Auger Observatory
The observatory focuses on the study of the spectrum and the composition of ultra-high energy cosmic rays. The Pierre Auger Observatory is the result of an international collaboration project and is located in Argentina's Mendoza Province.

PRACE – Partnership for Advanced Computing in Europe
PRACE is a network of supercomputer centres in Europe aimed at increasing the use of mathematical modelling for the solution of highly demanding research and practical tasks in the industrial sector. PRACE was established under the European Union's Seventh Framework Programme.

R

RDI OP – Operational Programme Research and Development for Innovation

ReCAMO – Regional Centre of Applied Molecular Oncology

RECETOX – Research Centre for Environmental Chemistry and Ecotoxicology
RECETOX is an independent institute of the Masaryk University's Faculty of Science, which is involved in research, development, education, and expert activities in the field of environmental contamination and toxic pollutants. The institute's special areas of interest included persistent organic pollutants (POPs), polar organic substances, toxic metals and their species, and natural toxins (cyanotoxins).

RS – Remote Sensing
The facility organisationally falls within the field of crystalline studies and specialises in the comprehensive interpretation of satellite and aerial images as well as all available geo-information products.

S

SDA – Sociological Data Archive

SHARE – Survey of Health, Ageing and Retirement in Europe
This project focuses on creating a publicly accessible international comparative database containing information on the status of the over-fifty generation and society overall throughout all of Europe.

SIAEOS – Svalbard Integrated Arctic Earth Observing System

SPIRAL2
The SPIRAL2 facility produces radioactive beams using the isotope separation method.

SSH – Social Sciences and Humanities

T

Tevatron
Tevatron is currently the most powerful American particle accelerator, which has been operating since 1983. Tevatron is a part of the Fermi National Accelerator Laboratory (Fermilab), a governmental laboratory located in Illinois. Worldwide, it is the second most powerful accelerator after CERN's LHC accelerator in Europe.

ThALES – Three Axis Low Energy Spectrometer
This project (which falls under the ILL20/20 programme) involves the development of a unique spectrometer for the study of low-energy inelastic neutron scattering.

X

XFEL – X-ray Free Electron Laser
XFEL is an international infrastructure focusing on the generation of intense X-ray radiation and its use in modern materials research.

2. Composition of the Working Groups

Peer Review Group

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prof. Ing. Jaroslav Kadrnožka, CSc., Energy
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prof. RNDr. Libor Grubhoffer, CSc., Delegate from the Czech Rectors' Conference
prof. RNDr. Zdeněk Stuchlík, CSc., Delegate from the Council of Higher Education Institutions

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Ing. Jiří Sitera, University of West Bohemia in Pilsen

3. Tabulka projektů

Name of the large infrastructure	National coordinator	Infrastructure type	Research priority	Notes
SOCIAL SCIENCES AND HUMANITIES				
BHCL (Bibliography of the History of the Czech Lands)	Institute of History of the ASCR	National	8	Existing
CESSDA	Institute of Sociology of the ASCR	Czech node under ESFRI	6, 8	Existing
ESS – survey	Institute of Sociology of the ASCR	Czech node under ESFRI	6, 8	Existing
LINDAT/CLARIN	Charles University in Prague	Czech node under ESFRI	6, 8	Existing
SHARE	Economics Institute of the ASCR	Czech node under ESFRI	6, 8	Existing
ICNC (Institute of the Czech National Corpus)	Charles University in Prague	National	6, 8	Existing
ENVIRONMENTAL SCIENCES				
CzechCOS/ICOS	Global Change Research Centre of the ASCR	Czech node under ESFRI	1, 2, 3	Existing
CzechPolar	Masaryk University and the University of South Bohemia in České Budějovice	National	1	Existing
CzechGEO/EPOS	Institute of Geophysics of the ASCR	Czech node under ESFRI	1	2015 – base exists
RECETOX	Masaryk University	National	1	Existing
PHYSICS AND MATERIALS ENGINEERING				
ELI	Institute of Physics of the ASCR	ESFRI	3, 4	New proposal – 2015
PALS	Institute of Plasma Physics of the ASCR and Institute of Physics of the ASCR	National	3, 4	Existing
MLTL	Charles University in Prague	National	4	Existing
LNSM	Institute of Physics of the ASCR	National	4	Existing
SAFMAT	Institute of Physics of the ASCR	National	4	Completion in 2013
CANAM	Nuclear Physics Institute of the ASCR	National	4	Existing
Van den Graaff	Czech Technical University in Prague	National	4	Existing
Wind tunnels	Aerospace Research and Test Establishment (VZLÚ, a.s.)	National	5	Existing
CEITEC – Nanostructure and advanced materials section	Masaryk University and Brno Technical University	National	4, 5	2014/15 – base exists
CERN	Institute of Physics of the ASCR	International organisation	3, 4, 5, 6	Existing
Tevatron Fermilab	Institute of Physics of the ASCR	International organisation	4	Existing
Pierre Auger Observatory	Institute of Physics of the ASCR	International organisation	4	Existing
LSM/JOULE	Czech Technical University in Prague	International organisation	4	Existing
ESRF & ESRF Upgrade	Institute of Physics of the ASCR	ESFRI, International organisation	4	Renovation – 2018
ILL	Charles University in Prague	ESFRI, International organisation	4	Existing
ThALES (ILL 20/20 Upgrade)	Charles University in Prague	ESFRI, International organisation	4	Renovation – 2012
ESS – Scandinavia	Nuclear Physics Institute of the ASCR	ESFRI	1, 4	New proposal
ELETTRA – MSB	Charles University in Prague	International organisation	4	Existing
GSI	Nuclear Physics Institute of the ASCR	International organisation	4	Existing
ESO	Astronomical Institute of the ASCR	International organisation	4	Existing
ENERGY				
LVR-15 and LR-0 Reactors	Řež Research Centre (Centrum výzkumu Řež, s.r.o.)	National	3	Existing
JHR	Řež Research Centre (Centrum výzkumu Řež, s.r.o.)	ESFRI	3	2014
COMPASS and ITER	Institute of Plasma Physics of the ASCR	National; partner for the ITER project	3	Existing
HiPER	Institute of Physics of the ASCR	ESFRI	3	Preparatory phase – 2018
BIOMEDICINE				
BBMRI_CZ (Bank of Clinical Samples)	Masaryk Memorial Cancer Institute	Czech node under ESFRI	8	Existing
EATRIS/EATRIS-CZ	Palacký University in Olomouc	Czech node under ESFRI	8	New proposal
INFRAFRONTIER	Institute of Molecular Genetics of the ASCR	Czech node under ESFRI	2	New proposal
Euro-BioImaging	Institute of Molecular Genetics of the ASCR	Czech node under ESFRI	2, 6	New proposal
INSTRUCT	Masaryk University, BIOCEV	Czech node under ESFRI	2	New proposal
CZ-OPENSCREEN	Institute of Molecular Genetics of the ASCR	Czech node under ESFRI	1, 2	New proposal
Centre for Systems Biology	Institute of Nanobiology and Structural Biology of the ASCR	National	1, 2	New proposal
ECRIN/CZECRIN	Masaryk University and St. Anne's University Hospital in Brno	Czech node under ESFRI	2, 8	New proposal
INFORMATICS/e-INFRASTRUCTURE				
CESNET	CESNET, z.s.p.o.	Czech part of GÉANT, EGI	6,8	Existing, restoration – 2015
CE IT4Innovations	VŠB – Technical University in Ostrava	Czech partner of ESFRI	6	New proposal – 2014
CERIT – SC	Masaryk University	National	6	2014 – base exists

The table provides a list of the projects included in the Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic. The large infrastructures are separated according to the priority of the applicable area of applied research as follows: 1 – Biological and ecological aspects of sustainable development; 2 – Molecular biology and biotechnology; 3 – Energy sources; 4 – Materials research; 5 – Competitive engineering; 6 – Information society; 7 – Security and defence; and 8 – Development priorities of the Czech Republic.

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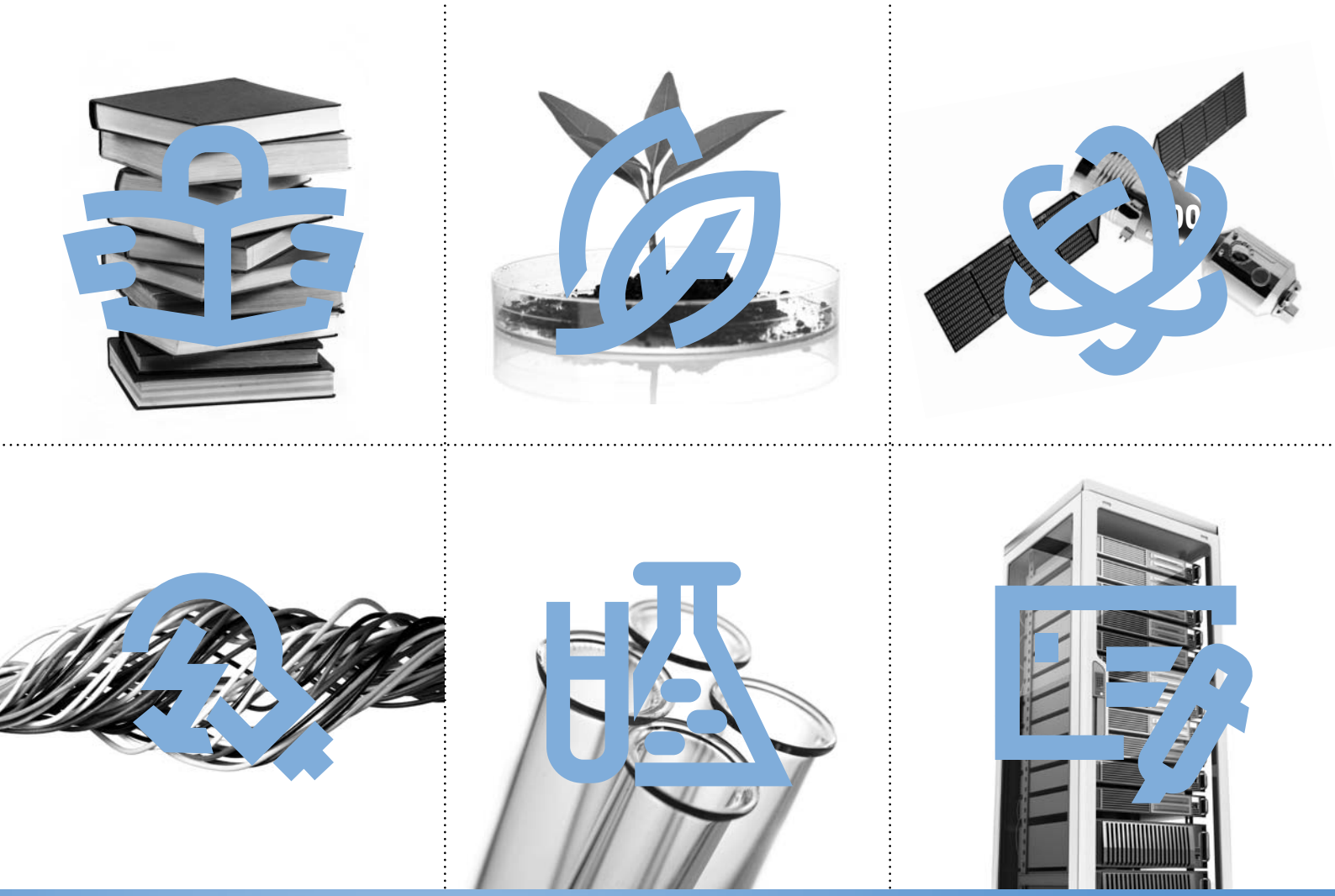

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