

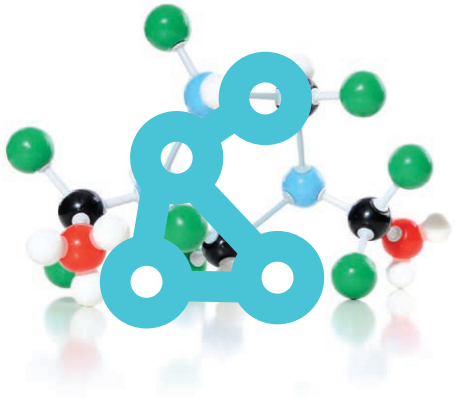


Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic

Ministry of Education, Youth and Sports

MINISTRY OF EDUCATION, YOUTH AND SPORTS

2007–13
OP Research and Development for Innovation

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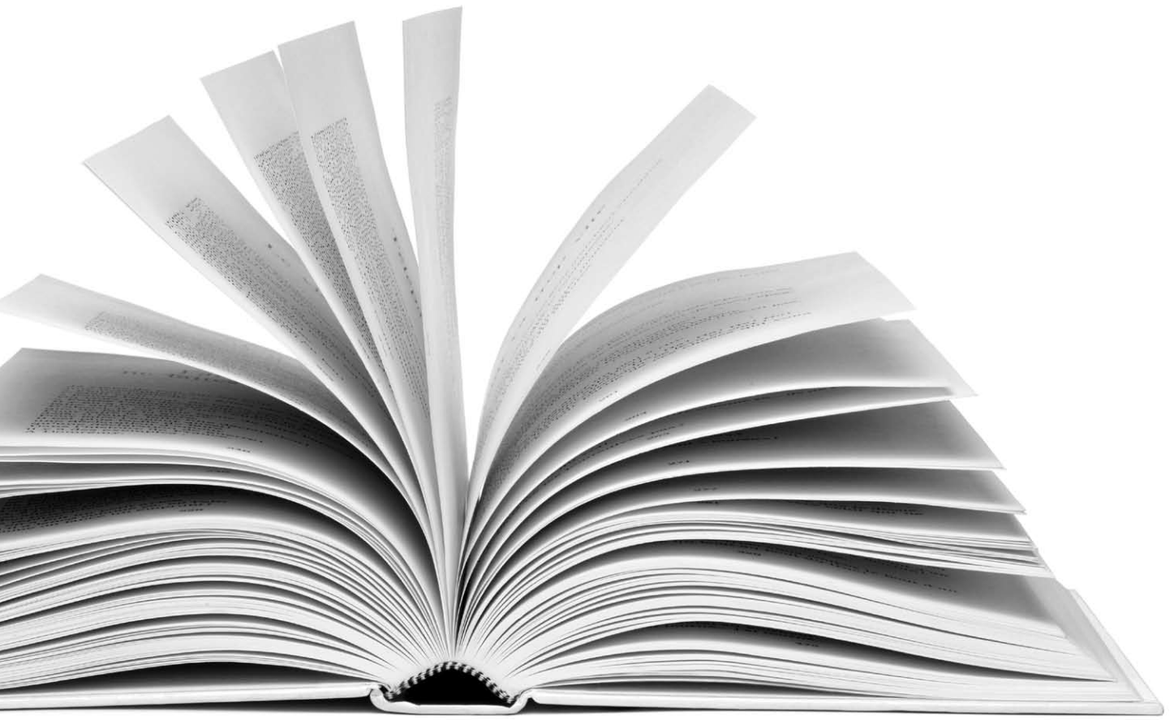

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Introduction

part A

The Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic was approved by Government Decree No. 207 of 15 March 2010 as a strategic document for development of large infrastructures for research, development and innovation. This document was drafted with participation of leading researchers from the Czech Republic in cooperation with state administration officials and key players in the research and development process. The document aims to describe the situation and significance of large research, development and innovation infrastructures within the Czech Republic, as well as the European Research Area, opportunities arising from financing of these types of facilities from the Structural Funds, and participation of the Czech Republic in projects under the so-called ESFRI Roadmap. Furthermore, the document provides an overview of major projects from 6 areas – social science and humanities, environmental sciences, materials physics and space, energy, biomedicine and informatics/e-infrastructure. Each of these areas includes a description of the current status, a SWOT analysis and high-priority and promising projects. The Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic will be updated at intervals depending on the development and dynamics of implementation of this first version.

1. The Czech Republic in the Context of the European Research Area (ERA) of Research, Development and Innovation Infrastructures

The need for revising the approach to the European Research Area has been widely discussed in the European Union during the last two years. Certain visions have been drafted and their implementation is being discussed. The current status of financing and coordination of activities in large research, development and innovation infrastructures within the ERA, which are considered a major condition for conducting excellent research, is no longer adequate for the new situation in establishing pan-European infrastructures under the ESFRI Roadmap and large research, development and innovation infrastructures (hereinafter only as a "large infrastructure") established with the assistance of the Structural Funds.

By 2020, the European Research Area should be consisted of mutually cooperating facilities with coordinated activities. The excellence of research should be ensured by providing the access to research capacities for the best projects selected through competition (the so-called open access). Researchers should be able to alternate their research locations in various facilities freely and without any barriers. The segmentation of research, education and industrial policies should be overcome and large infrastructures should become meeting platforms, where cooperation with universities in creating new study programmes and collaboration with research institutions in solving key scientific problems takes place, and where strategies for knowledge transfer into the industry and innovations are created in cooperation with the industry. Boundaries of these activities should not be defined by sectors or regions but the activities should be anchored in the European and national environment.

The Czech Republic has a chance to contribute to creation of ERA large infrastructures by participating in projects of pan-European significance explicitly listed in the ESFRI roadmap (or schemes relating to these projects) and by involving large infrastructures established with the assistance from the Structural Funds and other national resources in international projects or networks. Development of regional partner infrastructures should eventually raise the status of these infrastructures to large infrastructures of pan-European significance. Coordination of research policies with European standards and the applicable policies are another important aspects of the Czech Republic's involvement in the ERA. This will be ensured by specific conditions applicable to granting public subsidies. The required documents will include human resource development strategies, evidence of cooperation with universities and studies of the socio-economic impact of the relevant large infrastructures. This roadmap for large infrastructures in the Czech Republic will also help Czech infrastructures in their integration in the European community.

The roadmap for large infrastructures in the Czech Republic is not an initiative without background. Czech researchers have been partners in CERN since 1991, ILL 20/20 (since 1998), ESRF (since 1999) and in ESO since 2007. The INGO programme (the Ministry of Education, Youth and Sports) allowed financing projects implemented in the research infrastructures listed above and other similar infrastructures, including projects implemented in locations outside Europe, such as the Pierre Auger Observatory currently established by Czech scientists in Argentina. Some very interesting large infrastructures were also established in the Czech Republic during the last 20 years. Examples include the PALS laser laboratory and the COMPASS tokamak.

The Czech Republic has been participating in the preparatory phase of ESFRI Roadmap projects, namely CESSDA, CLARIN, SHARE, ICOS, HiPER, JHR, ELI, INFRAFRONTIER, since 2006 and participation in additional projects is being negotiated. Integration in the ERA in e-infrastructure also appears promising. The CESNET project is a part of the GÉANT worldwide network and the integration in the EGI grid infrastructure and among the PRACE supercomputer partners is highly probable. The question we need to ask ourselves is no longer whether the Czech Republic belongs to the ERA, rather how we can make an optimal use of this chance.

2. Structural Funds and Their Utilisation in Establishment of Large Research, Development and Innovation Infrastructures

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

The Czech research environment currently faces a great challenge as the Structural Funds essentially offer an opportunity to use funds from the European Union to implement scientific projects and plans and contribute to the Czech Republic's integration in the European Research Area.

During the period 2007 – 2013, a total of 24 operational programmes, additional two Interact II programmes (service programmes intended exclusively for control structures of operational programmes under Objective 3) and the ESPON 2013 programme aimed at assisting R+D in territorial planning and regional development are underway in the Czech Republic under the Structural Funds. These programmes are divided between the following 3 objectives of the economic and social cohesion policy: Convergence Objective, Regional Competitiveness and Employment Objective, and European Territorial Cooperation Objective.

Seven regional operational programmes for support and development of regions (NUTS II) and 8 topical operational programmes have been prepared under the Convergence objective. One of the topical operational programmes for regions – Operational Programme Research and Development for Innovation (OP RDI) is aimed at improving the competitiveness of the Czech Republic and creating highly qualified jobs through improved conditions for the existence and operation of research, development and innovation centres, universities, etc. The OP RDI supports the capacity increase of the existing R&D centres and establishing new institutions in regions within the Czech Republic, as well as accelerating the transfer of R&D outcomes into practice and their application in the industry and the market.

A total of EUR 2.43 billion has been made available for the purposes of this operational programme, of which 85% (EUR 2.07 billion) is financed from the European Union and 15% (EUR 0.36 billion) from the state budget of the Czech Republic. The implementation period for drawing these funds has been determined from 2007 to 2013 or 2015.

Applicants for subsidies under the OP RDI have started proposing their projects in the regular and major project categories. Major projects are defined as projects with amounts exceeding the total cost threshold of EUR 50 million (eligible and ineligible cost, including VAT). Implementation of major projects is subject to an approval by the European Commission in accordance with the General Regulation (this is why certain additional information needs to be submitted in the case of major projects). The so-called pre-call for the proposal of major projects under the OP RDI took place in July 2008. Partnership with the European large infrastructure ESFRI and continuity with the 7th framework programme were among the key selection criteria. The aim of this pre-call was to create an indicative list of major projects that are relatively well prepared and are promising with regards to potential benefit for the Czech Republic. Six projects were included in this list. As at 16. 11. 2009, a total of 5 major projects were proposed under Priority Axis 1 and 3 major projects were proposed under Priority Axis 2 during the project application submission. The planned allocation for this call is CZK 17 billion.

ELI – Extreme Light Infrastructure

The aim of this project is to build an excellent large laser infrastructure of a pan-European significance in the Czech Republic. This is the only project planned under the ESFRI Roadmap based in the Czech Republic. The ELI will strive to create a sufficiently intensive laser to ensure that electron-positron pairs are generated through photon interaction. Possible applications of this facility will include a wide range of research and innovation activities.

BIOCEV – Biotechnology & Biomedicine Centre

The aim of this project is to accelerate the establishment and the subsequent development of advanced biotechnologies in the Czech Republic by building a biotechnological and biomedical centre of excellence (BIOCEV).

CEITEC – Central European Institute of Technology

This project aims to increase the regional and national competitiveness by creating a sustainable "drive" generating regional innovative capacity in biosciences, biomedicine and advanced materials and technologies.

IT4Innovations

The project for building the IT4Innovations centre of excellence focuses on the area referred to in the long-term research and development plan for the Czech Republic as information society development. The project involves establishing a supercomputer for the purposes of the academic and application sectors.

Sustainable Energy

The key objective of this project is to create a facility focused on researching the utilisation of nuclear and other physical and chemical processes for achieving sustainable development in particular in energy and the subsequent development of safe and effective (conventional and unconventional) technologies used in energy and in the fight against life-threatening diseases.

CVEVL – Centre for Research of Energetic Exploitation of the Lithosphere

The objective of the CVEVL project is to establish a specialised research centre for researching options in utilisation of geothermal energy as a clean energy source. The CVEVL project aims to establish a network of well-equipped regional facilities specialising in applied research of energetic exploitation of the lithosphere.

ICRC – International Clinical Research Center

Cardiovascular and neuroscientific research as the primary focus of the ICRC project may extend into oncology and other fields. The key strategic partner is the American institution Mayo Clinic, which is considered the most prestigious medical facility in the world.

CERIT – Centre for Educational Research and Innovation in Informatics

The aim of this project is to establish a first-class educational and research and development centre for modelling and simulation aspects with high computational requirements, processing large volumes of data and intensive cooperation among university education, university research and development and innovative industrial entities.

3. Involvement of the Industry

Large infrastructures are a meeting place for specialists from universities, research institutions and the industry. Industrial enterprises participate in the design and construction of large infrastructures through construction work and manufacture of highly specialised components of measuring apparatuses within the constructed large infrastructures. During the operational phase, industrial enterprises are involved in maintenance or restoration or large infrastructures, use the services offered by large infrastructures and utilize measurement results in their product innovation efforts.

Experience with large infrastructures abroad shows that the long-term economic return is estimated as follows: about 70% of operating costs (cost of labour, supplies and technical equipment) is invested into the economics in the location where the relevant large infrastructure operates. Support for establishment and development of large infrastructures in regions and construction of new educational infrastructures or reconstruction of existing educational infrastructures including involvement of the public R&D sector in meeting the requirements formulated by the application sector will lead to gradual reinforcement of the innovative capacity and eventual application of the outcomes of R&D. Participation of partners from the research and application sectors will be beneficial to the fulfilment of the strategic direction of the public research, support of entrepreneurial activities and utilization of intellectual property, technological transfer and commercialisation of the outcomes of R&D. The impact of infrastructures on the development of human resources in research is indisputable. Studies with the opportunity to work in a creative and motivating environment of large infrastructures attracts university students and lecturers alike. As students meet with representatives of the industry within large infrastructures, these infrastructures also help to boost the mobility among sectors and employment of students in research and innovation departments of industrial enterprises.

Distribution of Large Infrastructures

According to Research Focus

The following material provides an overview of the current strengths and weaknesses, strategy and selection of projects according to the focus of research relevant to individual infrastructures.

part **B**

1 Social Sciences and Humanities (SSH)

1.1 Current Status

Research in SSH is experiencing long-term dramatic growth of production and application of data. Effective efforts are conditional on sharing and multiple application of data as 1) their research value exceeds the boundaries of individual projects; 2) costly creation of databases requires pooling of resources; and 3) combination of databases creates new research material.

The need for database generation, longitudinal studies and improvement in the accessibility of the existing data resources for research purposes across a range of fields in SSH and for the ability of research to contribute to the society's development are documented for example in the National Research, Development and Innovation Policy of the CR for the period 2009 – 2015 (section III. 8.2). Key priorities in SSH include studies of social development and preservation of the national memory. These lead to the need for long-term systematic collection of data and cumulative gathering of material. Interruptions, insufficiently systematic processes and loss of archived materials cause irreparable damage. Long-term sustainability of a range of activities is therefore vital for the success of the current and future research. Effective fulfilment of these needs can be achieved through large infrastructure development.

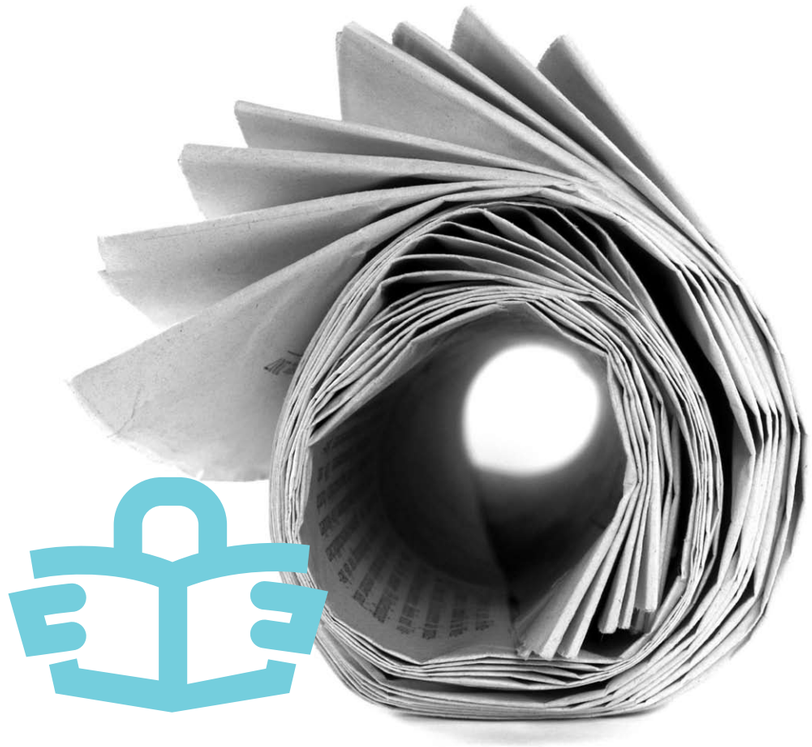
Digitalisation, introduction of new technologies and internet systems for database access changes the methods applied in research organisation in many fields. Opportunities for the use of different data types broaden, analytical methods change and cooperation opportunities based on data sharing grow. Data from actual researches become easily accessible for tertiary tuition, dependence on centres decreases and conditions for achieving excellence in regional research are created. Modern large infrastructures thus become vital for the competitiveness of Czech research in SSH and its participation in international cooperation.

Processes involved in continuous database generation and maintenance, integration of scattered data resources and creation of access to data extend beyond the boundaries of individual research institutions and often even national boundaries. Distributed and virtual infrastructures are a frequently used format. Infrastructures in SSH are also typically associated with high demands on qualified labour, while investments into technical equipment tend to be lower.

The large SSH infrastructure in the Czech Republic is currently scattered among a multitude of resources of a relatively small scope and with various degrees of accessibility. Many long-term activities are organised according to individual short-term projects, while other activities are threatened by termination of research plans. The infrastructures listed in the Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic (hereinafter only as the "Roadmap") help to improve the unsatisfactory status quo by interconnecting data resources and/or focusing on systematic continuous database generation.

Long-term provision of a publicly accessible large infrastructure unique within one or more fields with a broad application potential, significant connection to international research and a high intensity and large scope of these activities is the primary aim of these projects. The impact of large infrastructures on education and applied research was also taken into account. These projects can be divided according to types of activities into long-term continuous data collection programs, infrastructures interconnecting and disseminating data from various sources, and infrastructures combining both of the approaches referred to above. The following overview describes the current status of the Czech large infrastructure in SSH.

The Bibliography of the History of Czech Lands (BHCL) of the Institute of History, Academy of Sciences of the Czech Republic, v.v.i., is a long-term program generating a database of bohemical literature on history and related sciences, which processes electronic databases and makes them publicly available, creates and publishes bibliographical summaries and conducts literature searches. BHCL supplies data into international bibliographical databases. The linguistic data centre LINDAT/CLARIN is a project of the Institute of Formal and Applied Linguistics at the Faculty of Mathematics and Physics, Charles University and partner institutions (Masaryk University in Brno, University of West Bohemia in Plzeň and Czech Language Institute, Academy of Sciences of the Czech Republic, v.v.i.), which is currently in its preparatory phase. This project combines objectives of interconnecting and providing access to language resources, and developing language technologies and should function as the service centre for generation, processing and distribution of language data integrated in the Europe-wide network CLARIN (Common Language Resources and Technology Infrastructure). The European Social Survey (ESS) is a long-term international programme focused on continuous collection of data for basic indicators necessary for explaining interactions among institutions in the transforming Europe and the attitudes, beliefs and behavioural models in various populations. Czech participation has been ensured since 2002 by the Institute of Sociology, Academy of Sciences of the Czech Republic, v.v.i. SHARE (Survey of Health, Ageing and Retirement in Europe) is a longitudinal multidisciplinary survey programme established in 2004 with the aim to generate a publicly accessible international comparative database on the condition of the elderly and the entire society across Europe. Czech participation is in the hands of CERGE-EI, a shared facility of the Charles University and the Economics Institute, Academy of Sciences of the Czech Republic, v.v.i.. The Sociological Data Archive (SDA) of the Institute of Sociology, Academy of Sciences of the Czech Republic, v.v.i., gathers data from socioeconomic surveys to make them publicly available and ensure their repeated use, creates facilities for large international and repeated surveys, functions as a major node for European data organisation network CESSDA and supplies data into a range of international databases. This project is currently involved in the preparation of a joint European data service system under the CESSDA project. The Institute of the Czech National Corpus (ICNC), Faculty of Arts of the Charles University focuses on generation, maintenance, and providing public access to the largest general database of the contemporary and past Czech language. Numerous national and international institutions are partners under this project. The facility participates in international projects including the CLARIN project (see above).



1.2 SWOT Analysis

Strengths

- Extensive production of data suitable for sharing;
- Participation in prestigious international large infrastructure projects;
- Long-term tradition of summarisation and archiving activities;
- Developed IT infrastructure and availability of new technologies.

Weaknesses

- Long-term underfinancing, lacking funds for the operation threaten continuity;
- Small capacity;
- Dispersion, insufficient coordination, concentration and interconnection of resources, mutually incompatible systems;
- Non-existence of longitudinal data, discontinuity of implementation of long-term surveys;
- Frequent insufficient accessibility.

Opportunities

- Strong demand in basic and applied research;
- Czech scientific community open to sharing research material;
- Opportunities for cooperation under international networks combined with effectiveness arising from resource and cost sharing;
- Fulfilment of policy priorities in the support of international cooperation, education, regional development, applied research and ensuring effectiveness of public investment into research;
- Compliance with the priorities of the European Commission.

Threats

- Persistent lack of finance;
- Lacking knowledge of new opportunities and preparedness for new financing mechanisms;
- Possible disruption of the environment for cooperation and data sharing in research;
- Non-existent or unsuitable methodology for large infrastructure assessment;
- Domestic conditions incompatible with obligations under international networks.

Proposed solution

Conceptual policy derived from the requirement of the infrastructure types for long-term financing as referred to above needs to be introduced in large infrastructures for SSH as the importance of SSH research depends to a great extent on the ability to compare data from a long-term perspective. Projects ensuring reduced fragmentation of the national infrastructure and increased interdisciplinarity of research in addition to involvement of the Czech environment in the ERA are suitable for receiving support.

1.3 High-priority Projects

The existing infrastructure and projects of pan-European significance in their preparatory phase

BHCL

BHCL – Bibliography of the History of Czech Lands is a continuous programme for generating, processing and assessing a comprehensive bibliographical database of bohemical literature, which applies modern methods to follow up on the activities commenced in 1905. This project is one of the main information sources for historical and related sciences (archaeology, ethnology, preservation of monuments, historical geography and cartography, historical onomastics and toponomastics, historical demography, etc.). The BHCL 1) provides public online access to the databases; and 2) searches for bibliographical catalogues and annual almanacs, and conducts literature searches. The BHCL hands over data to major international bibliographical databases within the ERA, participates in international data exchange and is involved in the European Historical Bibliographies project focused on interconnecting databases. The BHCL utilizes modern technologies and the level of services offered is among the highest in Europe. It is an existing infrastructure operated as part of a research plan of the Institute of History, Academy of Sciences of the Czech Republic, v.v.i. In order to maintain and continuously generate the database, the operating costs need to be covered once the research plan comes to an end and projects need to be implemented in view of technological development.

CESSDA

A centralised data archive, which gathers data from major projects, processes this data and makes them available for further use, ranks among essential infrastructures for socioeconomic research. Combination of databases generates new research material. Archives function as sources for chronological and international comparisons, multiplicatively increase the effect of investments into research studies, and play a major role in research methodology, survey organisation and dissemination of scientific information. The **CESSDA (Council of European Social Science Data Archives) project implemented under the ESFRI** establishes a uniform European data service system. Interconnection of national archives associated in the existing CESSDA network with new participants in the network will create access to data sources regardless of data location in the ERA and will have a significant impact on national comparison opportunities, extension of data sources, methodological resources and increased standard of services. National archives will operate as the key nodes of the infrastructure and national data services will be reinforced. The availability of international databases with Czech data is a major condition for achieving excellence and participating in international cooperation. The Sociological Data Archive of the Institute of Sociology, Academy of Sciences of the Czech Republic, v.v.i. (see above in part B 1.1) is the Czech representative in the CESSDA. Data depositors and users in the Czech Republic recruit from among research staff of universities, institutes of the Academy of Sciences of the Czech Republic, numerous other research organisations and state administration. The project offers extensive potential for application in education. Involvement of the CR requires an adequate share in the CESSDA-ERIC, extension of the capacity of the existing data services in the CR and coverage of the operating costs.

ESS – Survey

The **ESS (European Social Survey)** is a long-term international programme focused on studying the main social indicators and major social science issues with a special emphasis on continuous generation of a publicly accessible database for chronological and international comparison. The extent of this cumulatively generated database allows solving specific tasks with high demands on data file size. The ESS is currently being implemented in 36 countries. This project has been awarded the prestigious Descartes Prize. It is a leading large ERA infrastructure for social sciences with

extensive application across a range of fields and a major source of data for international comparative research, and also a starting point for involvement in international cooperation. Research workers and students from universities and research institutes, specialists employed in public administration, but also journalists in Europe and worldwide are the users of this infrastructure. Czech users account for a major part of the overall user group. The subsequent phase of the programme is being prepared under the ESFRI with a special emphasis on the continuity of research and comprehensive representation of the countries in the ERA. In the CR the ESS is represented by the Institute of Sociology, Academy of Sciences of the Czech Republic, v.v.i. since 2002. The aim of this project is to ensure systematic continuous implementation of the survey and processing of Czech data for the international ESS database.

LINDAT/CLARIN

The centre for linguistic data LINDAT/CLARIN, which is being established at the Faculty of the Mathematics and Physics of the Charles University focuses on generation of annotated linguistic data, interconnection of resources and distribution of these data, as well as development and distribution of technologies for linguistic research. The centre is designed as the Czech key node of the international network for sharing linguistic data and technologies **CLARIN (Common Language Resources and Technology Infrastructure)**, which is currently in the preparatory phase under the ESFRI and associates institutions from 32 countries. The project significantly overlaps into computer technology and mathematical and electrotechnical research and participates in the preparation of the "Network of Excellence" for linguistic technologies (7th FP project). LINDAT/CLARIN will represent a national reference source of linguistic data and will allow general access to data, including connection to databases abroad, technological instruments and services, and proven expertise. This plan has a broad potential use in linguistics and other fields in SSH, in administration and creation of information systems (libraries, documentation centres), in linguistic software applications and in modernisation of the pedagogical process (language tuition, language technologies, data processing). Partners from the Masaryk University in Brno (a member of the CLARIN network), University of West Bohemia in Plzeň and the Czech Language Institute of the Academy of Sciences of the Czech Republic, v.v.i. in Prague cooperate under this project.

SHARE

SHARE (Survey of Health, Ageing and Retirement in Europe) is a longitudinal multidisciplinary programme for studying people older than 50 years of age and their families, which focuses on the economic, social, psychological and medical factors of ageing for the purposes of their research in mutual interaction across Europe. The outcomes of this project include a unique publicly accessible database allowing international and chronological comparison and the solution of specific research tasks. The gathered data find extensive application in socioeconomic research and extend beyond the boundaries of medical research. The data find their use in applied research, where they are used to formulate measures for social security, labour market, healthcare and education. Czech data find their way to users abroad through the new system. Surveys in 18 countries are currently underway and the data are compatible with similar projects implemented in USA and Great Britain. The SHARE project is a leading longitudinal programme under the ERA, it is a part of the ESFRI Roadmap and the construction phase of the SHARE-ERIC is currently in the preparation phase. Czech participation is ensured by CERGE-EI, the joint centre of the CU and the National Economic Institute, Academy of Sciences of the Czech Republic, v.v.i.

ICNC

The **ICNC (the Institute of the Czech National Corpus)** generates, maintains and analytically processes the most extensive data source for Czech language and makes it publicly accessible for research and development activities. The data source includes synchronous, diachronous and parallel linguistic corpuses (linguistic databases), which map the contemporary Czech, its development, functional and geographical variability, and contains texts translated between Czech and 20 foreign languages. What is more, the infrastructure provides modern technical facilities for the access to and analysis of databases. Corpuses represent the major large infrastructure for Czech linguistic research, which can also be applied in other fields of SSH. Corpuses find extensive application in education and language tuition in particular, and in applied research in information systems, translation, pedagogy and development of linguistic software applications. The creation of corpuses arises from cooperation with a vast number of institutions from the academic, as well as applied sectors, which deliver data. The ICNC is involved in international cooperation including the ESFRI project CLARIN. It is an existing infrastructure operated in the Faculty of Arts of the Charles University.

Table

Name of large infrastructure	Brief description	Infrastructure type	Year of completion
BHCL	Bibliographical database	National	Existing
CESSDA	Uniform European system for data services in social sciences	Major Czech node under the ESFRI	Restoration - 2014
ESS - survey	Collection of comparative data for the basic social indicators for researching interactions among institutions, attitudes, opinions and behavioural models	Major Czech node under the ESFRI	Restoration - 2016
LINDAT/CLARIN	Free sharing of linguistic data and technologies among research organisations with application in humanities and applied research	Major Czech node under the ESFRI	2013
SHARE	Studies conducted under the ERA focused on issues related to the population's health and ageing and socioeconomic topics	Major Czech node under the ESFRI	2020
ICNC	Data source for Czech language	National	Existing

1.4 Promising Projects

Recommendations for initiation and implementation of three projects are included for the purposes of a conceptual solution of the large infrastructure fragmentation and the discontinuity of long-term activities are some fields of SSH. These proposals aim to integrate and systematically develop the existing large infrastructure in the CR and draw from assessment of systems applied in large social science infrastructures operating in developed countries (such as Great Britain, Germany and the Netherlands).

Coordinated implementation of longitudinal socioeconomic surveys

Long-term international social science survey programmes are highly relevant for the priorities of the basic and applied research in the CR and obligations within the EU, OECD and international organisations. This involves a specified number of key international programmes, such as the OECD programmes (competitiveness and human resources), pan-European projects (such as the European Election Survey, European Value Study), etc. and major national longitudinal programmes. Surveys falling under these programmes are currently carried out in the CR primarily as part of individual short-term projects, without a systematic approach or sufficient coordination and with a negative impact on long-term objectives and effectiveness. We therefore recommend supporting a project focused on integrating and developing the existing activities to interconnect institutions implementing longitudinal surveys in a single network, facilitate coordination of activities and create an environment for effective solutions as part of implementation of an integrated programme with clearly defined research priorities, policy of free access to data and participation in international cooperation.

Digitalisation and access to research material in cultural heritage

Many research organisations possess extensive collections of research materials in cultural heritage and create and maintain these collections under their own systems with varying technological capacities and different levels of access for external users. The sustainability of these resources is one of the conditions for the success of the current and future research. Digitalisation and new technologies allow us to provide broad access to these data and facilitate their intensive use. We therefore recommend supporting a project focused on a distributed infrastructure to connect relevant resources, support digitalisation of research materials, establish uniform access and information system, facilitate coordinated and effective development and implementation of technologies and integrate these resources in international systems under the ERA. The objectives of this project are in accordance with the aim of the existing DARIAH project under the ESFRI process, which does not have a Czech partner yet.

Bibliographical and information databases

Research organisations operating in SSH administer numerous bibliographical and information databases, which often complement each other. We recommend supporting a project that would establish a uniform access and information system and coordinate processes involved in the administration and generation of these databases in order to facilitate and expand the application of these resources in research. Databases are of great importance for research under the National Reference Framework for Excellence. Their interconnection would help to create an infrastructure complementing similar systems operating under the ERA and intensify international cooperation.

Environmental Sciences (ENVI) 2

2.1 Current Status

Issues addressed in environmental sciences have a long-term tradition in the CR relating to current problems in creation and conservation of the environment and permanently sustainable development strategies, as well as the development of the knowledge base of environmental sciences and the breakthrough of new methodological procedures (molecular ecology, remote sensing, e-databases, modelling). Database and data sharing is also being newly promoted.

Numerous monitoring networks currently operating in the CR could form the basis for establishing a large infrastructure for research efforts in this area. However, these networks are disadvantaged by great differences in their quality of operation and operating systems. In addition, the high number of operators and sources of finance leads to data fragmentation and limited usability of these structures.

The requirement of long-term systematic and high-quality data collection, processing and cumulative gathering and production of syntheses is one of the greatest specifics of environmental sciences. Interruptions, unsystematic establishment of new observation points and loss of archived materials lead to irreparable damage. In this context it is necessary to point out that short-term projects in environmental sciences cannot guarantee high-quality research. Ecosystem processes, dynamics of changes in ecosystems or consequences of changes in landscape use – all of these are of a long-term character and the conventional system of grants therefore cannot lead to high-quality research and thus production of top-quality results. The current obligations of the CR in environmental sciences require implementation of long-term research. Research structures with lacking concepts and logistic preparation, which are terminated after a short period of time cause irreparable damage. Long-term sustainability of a range of activities is therefore the key condition for the success of the current and future research in environmental sciences and the ability of this field to fulfil the society's requirements for ecosystem services, including their sustainability.

Implementation of environmental science research with local focus is no longer sufficient. It is therefore necessary to use the existing structures as the basis for establishing a truly unique large infrastructure covering the entire territory of the CR with an open concept allowing its use in a wide range of fields. This requires a top-quality e-infrastructure capable of effective data transfer with a sufficient computing and storage capacity.

The need for development of modern research in environmental sciences and achieving truly interesting and topical results demanded by the society exceeds the boundaries of individual institutions. The participation of this type of research in the European Research Area therefore appears imperative. This involvement can be considered a key condition for achieving excellence in the CR, as well as for successful breakthrough of the national research potential in environmental sciences in international cooperation.

As environmental research was originally a field of a great breadth, narrowing this field under the Roadmap of Large Infrastructures in the CR for research in this area is essential. This is the only pathway to achieving true excellence and ensuring the CR's position within the ERA. The primary objectives of large infrastructures supported under the Roadmap must include long-term operation of an infrastructure for a unique field with a high intensity of application and strong connection to international research.

The following text contains an overview of the current status of the Czech large infrastructures in environmental sciences:

A **system of ecosystem monitoring stations** and studies focused on the impact of global climate change on the carbon cycle of ecosystems in the CR currently operates in the CR. These ecosystem monitoring stations are involved in the preparatory phase of the ESFRI Roadmap project **ICOS (International Carbon Observation System)**. This system focuses on long-term monitoring and quantification of carbon flow (CO_2 – a major greenhouse gas) in the basic types of ecosystems present in the CR (forests, grassy ecosystems, wetlands and agrocenoses). Monitoring the dynamics and magnitude of these carbon felonies according to the external environment parameters is carried out through a system of long-term fumigation of forests with increased concentrations of CO_2 in order to identify the development of forests with an increasing content of CO_2 in the atmosphere. This project is managed by the Institute of Systems Biology and Ecology, Academy of Sciences of the Czech Republic, v.v.i., which also plays the role of the "national coordinator" for the preparatory phase of the ICOS infrastructure. **The Laboratory for Process Imaging and Remote Sensing (RS)** is a system including a hyper-spectral sensor and equipment for process imaging of ecosystem processes related to the carbon cycle in the scale of ground, aerial and satellite images. The laboratory is a part of the EUFAR infrastructure (European Fleet for Airborne Research). The project is managed by the Institute of Systems Biology and Ecology, Academy of Sciences of the Czech Republic, v.v.i. The **Czech polar stations in the Arctic and Antarctica** focus on comprehensive geological and biological research of polar areas. These stations are the property of the Masaryk University in Brno and the University of South Bohemia in České Budějovice. The **Centre for Biodiversity Research** focuses on the basic research of biodiversity (plants and animals) and training for specialists (training in the Centre's partner institutions) and is currently financed under the project of the Ministry of Education, Youth and Sports – Basic Research Centres. No conceptual approach to this area of expertise has been created so far. The project is managed by the Institute of Systems Biology and Ecology, Academy of Sciences of the Czech Republic, v.v.i. A highly fragmented **network monitoring seismic and geophysical phenomena within the national territory** operates in the Czech Republic. The activities of this network are financed from various sources and carried out by a number of universities and institutes of the AS CR. These stations are currently undergoing integration owing to their involvement in the ESFRI Roadmap project EPOS. The CzechGeo/EPOS project of integrated infrastructure is thus being established.

2.2 SWOT Analysis

Strengths

- Extensive production of data suitable for sharing;
- Participation in prestigious international projects;
- Long tradition of summarisation and archiving activities;
- Existing elements suitable for creation of a large infrastructure.

Weaknesses

- Long-term underfinancing;
- Small capacity;
- Dispersion, fragmentation, lack of coordination and strategic approach.

Opportunities

- Demand arising from the political will and adherence to the EU's priorities (ESFRI, 7th FP);
- Potential for transferring results into the application and innovation sector;
- The Czech scientific community open to sharing research materials;
- Opportunities for cooperation in international networks;
- Fulfilment of policy priorities in support, education, regional development, applied research and increasing the effectiveness of public investment into research.

Threats

- Persisting lack of finance;
- Lacking preparedness for new EU programmes – a low level of awareness;
- Non-existent of unsuitable methodology for infrastructure assessment;
- National conditions incompatible with the obligations of international networks.

Proposed solution

A conceptual policy arising from the social demand according to the priorities of the state's R&D policy for this area and priorities of the EU needs to be introduced in large infrastructures for ENVI. The long-term aspect of research and consequently the operation and financing of large infrastructures needs to be highlighted in connection with ENVI.

The following issues can be currently identified as high-priority areas under the national research strategy for ENVI:

1. Global climate changes covering the full scope of the problem, including biodiversity and overlaps into socio-economic consequences;
2. Research in specific areas (polar research);
3. Issues associated with seismologic research and geological sciences;
4. National collections.

2.3 High-priority Projects

CzechCOS/ICOS

CzechCOS/ICOS – The national centre for studying the impact of global climate changes is the Czech node under the pan-European infrastructure ICOS, EUFAR and LIFEWATCH. The infrastructure will provide facilities for observation research at the level of individual types of ecosystems present in the CR and operate laboratories for process imaging, including a domain focused on biodiversity research. CzechCOS/ICOS will create a platform for implementation of large infrastructures focused on biodiversity. CzechCOS will include a methodological apparatus that will allow gathering and processing information on energy and substance flows, biodiversity research and process imaging applications. CzechCOS is designed as a centre of excellence concentrating a major part of the national potential of experts in GCC with direct participation of top experts from abroad (members of the implementation team) and partnerships with major international institutions in the relevant field, which will be directly involved in the project solution. The concentration of knowledge potential with regard to the relevant issues implemented under the project will lead to its application in strategic decision making and support of technologies focused on alleviating the impact of GCC or adapting to the effects of GCC.

CzechPolar

The CzechPolar project – Czech polar stations in the Arctic and Antarctica – should eliminate fragmentation of activities and integrate the activities of both stations, while allowing the access to the large infrastructure to researchers throughout the CR. The main objective of the research carried out in the Antarctica, where J. G. Mendel's polar station is situated on the James Ross Island, is comprehensive research of the relatively young deiced area of the Antarctic coastline – the so-called coastline oasis, which is one of the few local environments allowing any existence of life. This research involves geological, physical and geographical and biological disciplines. This comprehensive research aims to identify the structure, development and functioning of the oasis in terms of mutual influence of its abiotic and biotic components, to forecast its further development and to model potential changes to this area caused by climate change. The second polar station in the Arctic is situated on the Svalbard archipelago. The aim of this project is to study the biological and climatic diversity and identify the relationship between diversity/productivity and climatic/microclimatic factors of the environment. Northern polar stations are suitable for training students in all fields of study related to polar climate conditions owing to easier access to these areas.

CzechGeo/EPOS

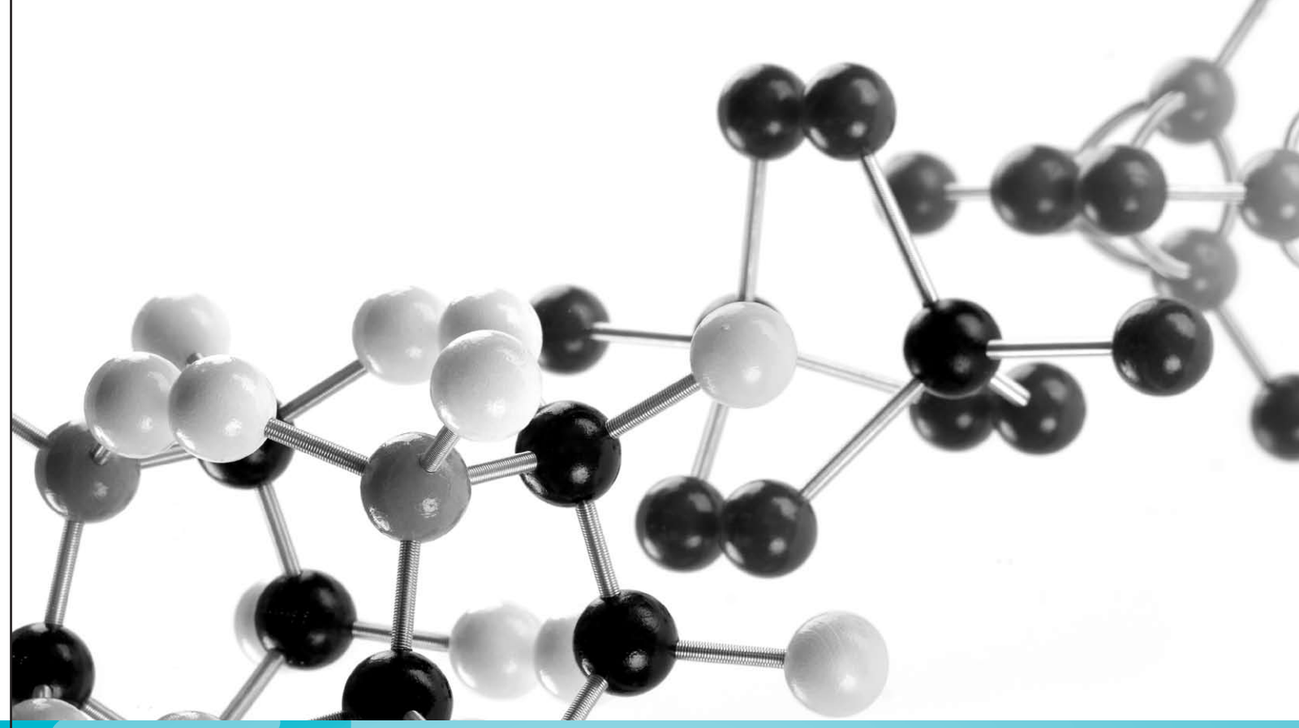
Fragmentation of activities in geophysics should also be overcome by establishing an integrated network of permanent seismic stations under the CzechGeo/EPOS project – Network for Monitoring Seismic and Geophysical Phenomena. The resulting integrated infrastructure will be the Czech part of the pan-European EPOS project focused on monitoring geophysical phenomena with a worldwide outreach. Permanent seismic stations within the Czech Republic will monitor earthquakes and other seismic phenomena in Central Europe and worldwide. The seismologic data centres of the IG in Prague and the IPE in Brno are responsible for collecting and archiving data from seismologic observatories, interpreting seismic signals, creating of bulletins and catalogues of earthquakes, international exchange of digital data and parameters of the registered seismic phenomena. The Czech network contributes with its data to the extensive international cooperation under the European Seismologic Centre ORFEUS in Holland, the worldwide data centre in Seattle and many other European national centres, thus contributing to prompt location of earthquakes anywhere in the world. The network is also involved in numerous European research programmes in geological sciences.

Table

Name of large infrastructure	Brief description	Infrastructure type	Year of completion
CzechCOS/ICOS	Monitoring system for energy and substance flows, process imaging and development of biodiversity under the impact of GCC	National node ICOS, EUFAR, LIFEWATCH	2015 Foundation in place
CzechPolar	Operation of J.G. Mendel's station in the Arctic, development of polar research in Antarctica	National	Existing
CzechGeo/EPOS	Established network of seismic stations, long-term measurement of seismic activities and phenomena	National node EPOS	2015 Foundation in place

2.4 Promising Projects

Research Centre for Environmental Chemistry and Ecotoxicology - RECETOX - An ecotoxicological research centre with a specialised profile and strong connections to an educational programme focused on environmental contamination with toxic substances. The centre specialises in particular in persistent organic pollutants (POPs), polar organic substances, toxic metals and their species and natural toxins (cyanotoxins) with a special emphasis on slowly degradable organic pollutants. RECETOX consists of four cooperating divisions: Environmental Chemistry, Ecotoxicology, Risk Assessment and Environmental Informatics and Modelling.



Materials Physics and Space 3

3.1 Current Status

The current research in material physics requires extensive technological facilities allowing the preparation of top-quality experimental samples in various forms (from thin layers and multilayers to nanoparticles or defect-free large monocrystals), equipment for reliable characterisation of structures and compositions, and apparatuses for measuring adequate sets of material parameters using complementing macroscopic and microscopic methods of measurement. The operation and development of certain unique facilities is very costly and often exceeds the financial resources or a single research organisation. Their effective utilisation can be achieved by integrating these facilities in large infrastructures serving the wider scientific community. Regular users will be able to carry out their research work within a short period of time and at minimal costs. Some of the laboratories operating in the CR meet the requirements for a national infrastructure.

In basic research of interaction of materials and radiation, the **PALS** research centre is one of such facilities. This joint facility of the Institute of Plasma Physics and the Institute of Physics, Academy of Sciences of the Czech Republic, v.v.i. has been used by researchers from local and European scientific institutions as a large infrastructure with a Europe-wide scope since 2000. PALS is a first-class facility for research and application of laser plasma, interaction of radiation with mass and X-ray lasers, and plays a major role in the development of laser sources of highly charged ions with energies in MeV/nucleon. Tasks carried out in this centre include research of properties of materials under extreme temperatures and pressures, and unique research and application projects in surface modification. The planned construction of the **ELI** under the ESFRI programmes will help to achieve excellence of these types of research in the CR in the field of the highest currently attainable energies. The ELI laser is a large infrastructure under the ESFRI and the Czech Republic has put forward its bid for having the laser located here. The laser will produce electromagnetic radiation (light) of extreme properties with a radiation intensity many times exceeding the current capacities worldwide. The laser will be used as a multiple purpose facility primarily in basic research of interaction between radiation and mass under the so-called ultrarelativistic regime for testing materials, development of new diagnostic methods in medicine and advanced radiotherapy methods, and for verification of new methods of obtaining energy from nuclear fusion using inertial confinement with lasers.

Material research in nanotechnologies is currently carried out in the CR mainly in the **Laboratory for Nanostructures and Nanomaterials (LNSM**) operated by Institute of Physics, Academy of Sciences of the Czech Republic and comprising two major parts – a laboratory for semiconductor nanostructures and a laboratory for voluminous nanomaterials. In addition, a wide range of measurements of physical parameters of materials under multi-extreme conditions (low temperatures, strong magnetic fields and high pressures) is offered by the **Magnetism and Low Temperature Laboratories (MLTL)** operated by the Faculty of Mathematics and Physics of the Charles University in Prague (FMP CU) in cooperation with the Institute of Physics, AS CR. The MLTL also provides Czech scientists with the access to international laboratories with strong magnetic fields (stronger than 14 T, which is the maximum magnetic field value currently achievable in the MLTL). The FMP CU in cooperation with the Institute of Physics Academy of Sciences of the Czech Republic also operates the **Materials Science Beamline at the ELETTRA Synchrotron in Trieste** and thus provides the Czech scientific community with unique experimental equipment for studying photoemission spectroscopy at one of the best synchrotrons in Europe.

Experimental opportunities arising from methods using interaction between neutrons and ions and materials at a microstructure level are offered by the **Centre for Modification and Analysis of Materials with Ions and Neutrons** operated by the Nuclear Physics Institute, Academy of Sciences of the Czech Republic, v.v.i. The Centre with its accelerators and equipment on the LVR-15 reactor covers a major part of requirements of the local scientific community, provides analytical and radiation services and facilitates training for emerging experts. The centre also maintains extensive contacts and bilateral cooperation with partners abroad in connection with solution of specific research problems. Cyclotron U-120M is used in studies of nuclear reactions, preparation of radionuclides for research and development and commercial manufacture of radiopharmaceuticals, and also serves as a unique source of fast neutrons. The electrostatic accelerator Tandetron 4130MC is used for material analysis with ion beams and material modification by ion implantation. The experimental equipment installed on the neutron radiation channels of the LVR-15 reactor (ÚJV Řež a.s.) are intended for structural and elementary analysis of materials with neutrons. The centre is one of the few neutron physics facilities in the CR included in the European project NMI3 – ACCESS to Large Facilities. The **Van de Graaff – proton accelerator HV2500** is also interesting in view of the need for broad access for educational purposes and attractive international cooperation. The urgent need for this type of adjustable monochromatic source of neutrons for the purposes of international cooperation has recently become especially apparent as the Institute of Experimental and Applied Physics of the Czech Technical University received 3 grants from the European Space Agency (ESA). The projects focus on neutron physics and one of the projects will involve adaptation of the HV2500 accelerator to the so-called "ESA approved neutron facility", which will be used for testing detectors for space research and associated electronics in view of their sensitivity to neutrons and resistance to space radiation.

Direct access to unique experimental apparatuses in large international laboratories for the Czech scientific community plays a key role in achieving excellence of the Czech physical material research. Since its conception, the CR has been a member of the **CERN** – the world's number one centre for studying fundamental properties of mass – and has actively participated in the centre's activities not only by participating in experiments such as **ATLAS**, **ALICE** and others, but also by obtaining interesting contracts for the supply of unique equipment. The country's participation in the D0 experiment carried out on the **Tevatron** facility in the Fermilab laboratory, USA, in the **Pierre Auger Observatory** experiment in Argentina (study of the highest energy cosmic ray showers), and in **LSM/JOULE** in France (neutron physics) is very important for development of particle physics in the CR.

The CR's long-term scientific membership in the **Max von Laue and Paul Langevin Institute (ILL)** in Grenoble provides excellent experimental opportunities offered by the strongest stationary source of neutrons worldwide, while the membership in the **European Synchrotron Radiation Facility** (ESRF) also situated in Grenoble offers extensive opportunities for experimenting using one of the strongest sources of synchrotron radiation. Continued scientific membership in these large international infrastructures is vital for ensuring the stability of Czech research. The programme upgrades currently commencing in the ILL and the ESRF (ILL 20/20 and ESRF upgrade) will raise many experimental apparatuses to a significantly higher standard and allow implementation of experiments that could not be implemented with the existing equipment. The Czech scientific community will participate significantly in the **ThALES** project under the ILL 20/20 programme with its in kind contribution aimed at construction of a new generation triaxial spectrometer for studying low-energy inelastic neutron scattering.

Development of excellent Czech research in material physics will also require the CR's participation in the large international infrastructures currently under construction, such as the **E**uropean **S**pallation **S**ource (**ESS**) in Lund (Sweden) in connection with neutron utilization, and **X**-ray **F**ree **E**lectron **L**aser (**XFEL**) in Hamburg focusing on intensive X-ray radiation. Involvement of Czech scientists in these infrastructures from early phases of preparation will ensure the country's acknowledged position in the international community and bring valuable outcomes from the very beginning of the infrastructure operation. Czech participation in the ESS has started to take shape; construction of a unique neutron diffractometer for studying materials in extreme conditions in the form of an in kind contribution to the ESS infrastructure has been negotiated with the ESS management.

The eligibility for bidding in prestigious tenders relating to the construction and updates of infrastructures arising from scientific membership is yet another major argument for the country's participation in these large international infrastructures.

Cooperation in newly planned facilities under the ESFRI SPIRAL2 and FAIR (Facility for Antiproton and Ion Research) will be important for the Czech scientific community from the long-term perspective. The **SPIRAL2** facility situated in the French GANIL laboratory is to ensure worldwide competitiveness even in 2015, when it is to reach its planned specifications. The facility will produce primarily radioactive beams (but naturally also intensive beams of stable ions) using the on line isotope separation method ISOL. SPIRAL2 is included in the list of major European large infrastructures ESFRI. **FAIR** will facilitate unique experiments with antiproton and heavy ion beams. This new European research centre implemented in GSI Darmstadt (Germany) contains an acceleration assembly comprising a number of new accelerators, accumulation rings and new experimental apparatuses. This assembly will provide proton, antiproton, heavy ion and exotic radionuclide beams for experimental purposes with energies up to 35 GeV, achieving unsurpassed intensity and allowing studies of physical processes in extreme conditions at levels that have not been achievable so far.

The **European Southern Observatory (ESO**) – an intergovernmental European organisation for space research established in 1962 is currently the most important partner for the CR in space

research. The ESO currently has 14 member states, the CR being a member since 2007. The main objectives of this organisation are as follows: space research from the Earth using first-class technologies, cooperation with apparatuses in the space, educational programmes in natural sciences and popularisation programmes involving the general public. The main benefits arising for the CR from its membership include the access to first-class telescopes, large projects and the ESO – ESA – NASA infrastructure is astronomy and astrophysics, and the eligibility to participate in construction of new apparatuses and obtain a wide range of contracts for manufacture of high-precision optic and optic-mechanical components. The Czech scientific community can benefit from active participation in scientific projects with telescopes situated on mountains La Silla and Mt. Paranal and in future with observation using the ALMA interferometer. Czech companies will have the opportunity to participate in construction of new facilities under the ALMA project, as well as the European Extra Large Telescope (E-ELT), which is listed in a prominent position within the ESFRI roadmap. The Astronomical Institute, Academy of Sciences of the Czech Republic, v.v.i. intends to support the exploitation of these opportunities by establishing the **Centre for Cooperation with the ESO and the ESA** and a regional node for the ALMA interferometer. The **European Space Agency** (ESA) is an international intergovernmental organisation for the development of space research and cosmic technologies established by the Convention of 30 May 1975. 18 European countries currently hold a full membership in the ESA: Belgium, Czech Republic, Denmark, Finland, France, Ireland, Italy, Luxembourg, Germany, Netherlands, Norway, Portugal, Austria, Greece, Spain, Sweden, Switzerland and Great Britain. Canada holds a special position of a cooperating member. The Czech Republic became the 18th regular member of the ESA on 12 November 2008. The financial contribution payable by the CR comprises a contribution for compulsory activities to the amount of EUR 5.6 million per year and a contribution for the selected optional programmes to the amount of EUR 1 to 2 million, depending on the actual progress of the programmes. When participating in particular projects, experts from the Czech Republic may use the ESA's infrastructure when needed.

In addition to the headquarters situated in Paris, ESA comprises five research centres and the European spaceport **Centre Spatial Guyanais (CSG)** in Kourou, French Guiana, and the European **Columbus module at the international space station ISS.** The individual research centres are listed below:

The **European Space Research and Technology Centre (ESTEC)** is the largest research centre of the ESA located in Noordwijk, Netherlands. This centre specialises in technology development and research in space physics and astronomy, microgravitation, telecommunication and Earth observation.

The **European Space Operations Centre (ESOC)** situated in Darmstadt, Germany ensures the operation of space objects in the orbit. The ESOC manages the operation of artificial satellites and planetary probes and receives and processes data from the European Columbus module at the international space station ISS for various scientific experiments.

The **European Space Research Institute (ESRIN)** is located in Frascati, Italy, near Rome. The ESRIN specialises in issues related to obtaining, processing and distributing data from satellite apparatuses used in Earth monitoring.

The **European Astronauts Centre (EAC)** in Cologne on the Rhine organises training for European astronauts and their preparation for specific flights.

The **European Space Astronomy Centre (ESAC)** in Spain concentrates capacities necessary for astronomic research carried out by space probes and satellites.

Equipment of the ESTEC centre – testing elements and satellite systems and onboard apparatuses, including modelling technological solutions for new products for space flight conditions, and equipment of the Columbus module at the ISS station are intended directly for scientific and research activities.

Equipment of the ESTEC centre:
- Testing centre;
- Electrotechnical laboratories;
- Mechanical laboratories;
- Mechanical system laboratories (sections: thermal, mechanical, thermal hydraulic, life systems);
- Laboratories for reliability and safety checks;
- Centre for design of complex systems.

Equipment of the Columbus module:
- Biological laboratory for biological experiments;
- Physiological laboratory;
- Laboratory for liquids research;
- Equipment for research of the Sun;
- Enclosed laboratory equipment (glove box);
- Adjustable holder for experimental equipment;
- Platform for fastening experiments inside the module.

3.2 SWOT Analysis

Strengths
- Scientific excellence, significant scientific outcomes;
- Uniqueness (such as CERN, TEVATRON, ESRF, ELETTRA, ESS, ILL, ThALES, MLTL, PALS, ESO, ESA, etc.);
- Cooperation between infrastructures (for example methodological complementarity and synergy in research of new materials a) MLTL (macroscopic methods), ESRF, ELETTRA, ILL, ThALES (microscopic methods); b) EMBL (preparation and characterisation of new biological materials), ESRF, ILL Grenoble (microscopic study of new biological materials);
- Extensive experience of Czech facilities;
- International acknowledgement of Czech facilities, such as LASERLAB-EUROPE, NMI3-ACCESS…);
- Recent construction of innovation (such as the construction of PALS, purchase of the new accelerator Tandetron, continuous innovation of experimental equipment on the LVR-15 reactor, MLTL, etc.);
- World-class astrophysical research;
- Involvement in major projects;
- Contracts under construction of the ALMA and E-ELT apparatuses.

Weaknesses
- Lacking finance for the operation and updates of the equipment threatens the permanent sustainability and development of certain infrastructures;
- The age of certain equipment (such as the cyclotron U-120M installed in 1977); replacement of the outdated equipment with more powerful and modern equipment would significantly extend the existing experimental capacities – current manner of financing infrastructure operation – in particular necessary repairs and maintenance, which has to be financed from resources obtained irregularly (from grants and one-off financial assistance);
- The share of finance coming from the private sector is negligible due to the weak or non-existent applied and targeted research in the Czech economy;
- Experiments with neutrons are carried out on the LVR-15 reactor operated by ÚJV Řež a.s.; financing of the reactor operation is an ongoing problem;
- Small number of companies capable of implementing highly demanding contracts;
- Underfinanced development of high technologies in the CR.

Opportunities
- Education for students and training for young scientists;
- Great interest in experiments from facilities within the country and abroad;
- Long-term cooperation with established partners in the CR and abroad, which will continue in future;
- Installation of new equipment (such as ELI, HiPER, PALS, ESO, completion of laboratories, etc.) opens or will open new cooperation opportunities;
- The interest in material physics will be intensified with the development of nanotechnologies, and the development of new materials and structures with smart surfaces and significant mechanical, electrical, magnetic, optical and biological properties;
- Training of a new generation of scientists capable of implementing astrophysical and ESO projects;
- Development of companies capable of implementing technically demanding contracts.

Threats
- Former undervaluation of the necessity of participation in significant infrastructures (ESS, XFEL, SPIRAL2, FAIR), which will be fully operating later in future;
- General lack of suitable young people who could be trained to continue in scientific work in large and demanding infrastructures once these are completed (see for example ELI);
- Overall lack of focus on the financing system for basic R&D; on the other hand, stable, institutional financing of large facilities of national and international significance would open these facilities to a broader group of users from the CR and abroad and increase the effectiveness of their utilisation;
- Lack of finance for E-ELT in astronomy.

3.3 High-priority Projects

Existing infrastructures and projects of pan-European significance in their preparatory phase – the highest priority

a Infrastructures within the CR

ELI

Laser ELI (Extreme Light Infrastructure) is a large infrastructure planned under the ESFRI – the Czech Republic has applied for placing the infrastructure within its territory. The infrastructure will produce electromagnetic radiation (light) of extreme properties with a radiation intensity exceeding the latest record achieved by the British Astra laser a number of times. It will be used as a multipurpose facility mainly in basic research of interaction between radiation and mass under the so-called ultrarelativistic regime for testing materials, development of new diagnostic methods in medicine and advanced radiotherapy methods, and for verification of new methods for obtaining energy from nuclear fusion using inertial confinement with lasers. Research carried out within the ELI will result in generation of a new generation of compact particle accelerators (electrons, protons, ions) or, for example, "desktop" X-ray lasers using free electrons. Construction of the ELI in the CR is a subject of a major project proposal submitted under Priority Axis 1 of the OP RDI. The plan to construct the ELI in the CR is supported by Decree of the Czech Government No. 1514 of 24 November 2008. The Consortium ELI-CZ associating a total of 14 research institutes of the AS CR and universities is also involved in preparation of the plan for constructing of the ELI.

PALS

The laser laboratory "PALS Research Centre" is a joint facility of the Institute of Plasma Physics, AS CR and the Institute of Physics, AS CR and is administered by the Institute of Plasma Physics. PALS is the funding member of the pan-European consortium LASERLAB-EUROPE and is also involved in inertial fusion research coordinated by EURATOM. The infrastructure possesses one of the largest lasers in Europe – a pulse terawatt iodine photodissociation laser PALS (Prague Asterix Laser System). The intensity of the focused beam on the target reaches tens of petawatts per cm^2. The main laser is further complemented by a plasma X-ray zinc laser developed in the PALS laboratory, which achieves world record parameters and operates at the wavelength of 21.2 nm. Extensive multidisciplinary application ranges from plasma physics, radiation physics, chemistry, thermonuclear and material research and laboratory astrophysics to the application of lasers and laser plasma in biology or medicine. Institutions cooperating at the national level include other institutes of the AS CR, FNSPE and FEL CTU.

MLTL

MLTL – The Magnetism and Low Temperature Laboratories situated in the premises of the FMP CU in Prague – Trója have a system of unique cryogenic and cryomagnetic apparatuses supplied with liquid He from a local liquefier, which also supplies liquid He to other university and academic laboratories in Prague and surrounding areas. The apparatuses in the MLTL offer students and other users from the CR and abroad high-precision and effective measurement of various physical properties of materials under multi-extreme conditions (combination of temperatures 30 mK – 1000 K, strong magnetic fields up to 14 T and high pressures up to 26 GPa) necessary for modern material research and comprehensive research of superfluidity and quantum turbulence. The laboratories were established in 1998 and according to the agreement between the FMP CU and the Institute of Physics, Academy of Sciences of the Czech Republic, v.v.i. are administered by the FMP CU. The MLTL also allow preparation and characterisation of high-quality samples of new materials.

LNSM

LNSM (Laboratory for Nanostructures and Nanomaterials) owned by the Institute of Physics Academy of Sciences of the Czech Republic, v.v.i. comprises two parts: the Centre for Preparation of Semiconductor Nanostructures, which is one of the key facilities of the Centre for Nanotechnologies and Materials for Nanoelectronics LC510 of the MEYS and is further supported for example under the 7^{th} FP. The centre allows preparation of semiconductor layers with atomic resolution and microchips based on these layers with electronic elements measuring mere dozens of nanometres. The laboratory has the necessary equipment for experimental studies of a range of quantum relativistic phenomena in physics of solid substances and for studies of properties of microelectronic elements with dimensions smaller than 100 nanometres. This centre comprises two main units – the Facility for Molecular Beam Epitaxy (allowing the preparation or thin-layer monocrystalline materials using the molecular beam epitaxy method) and the Facility for Lithographic Structuring of Thin-Layer Materials (allowing the preparation of lateral micro and nanostructures). The Centre for Voluminous Nanomaterials supported under the project included in the "Nanotechnology for Society" programme focuses on the technology for preparation of metal materials with ultrafine grain and nanocrystalline structures, their characterisation and study of significant physical and chemical properties. In addition to the new facility for mechanical tests operating at a temperature range from -150 to 1100ºC and a few shaping forms for the preparation of materials with extremely fine structure using intensive plastic deformation (the ECAP method), the fully furnished double beam electron and ion microscope including the necessary accessories is the key equipment of this centre. Next year, the laboratory will receive a cutting-edge analytical transmission electron microscope (TEM) for studying subnanometric structures.

SAFMAT

SAFMAT (Centre for Analysis of Functional Materials) is a project of the Institute of Physics, Academy of Sciences of the Czech Republic, v.v.i. under the 2nd call of the Operating Programme Prague-Competitiveness (OP-PC). The type of research facilitated by this project focuses on analysis of new materials in terms of their atomic composition and structure, which is one of the most demanding fields in experimental material physics requiring high concentration of material and human resources with high qualification. The research under the SAFMAT project also includes metrology of thin layers in nanotechnologies. SAFMAT also focuses on analysis of technologically significant centres and defects responsible for location of electric charge in semiconductor, magnetic and other materials. The applied method – the so-called electron paramagnetic resonance – is necessary for determining the concentration, charge status, valence and electron structure of these centres in an atomic scale and their manner of integration in the host structure. SAFMAT will include in particular two cutting-edge apparatuses for characterisation of nanostructure functional materials: NanoESCA is an apparatus combining in a unique manner electron microscopy of photoelectrons with electron spectroscopy for examination of chemical composition and structural properties in nanometric spatial resolution. The second apparatus – the EPR spectrometer – determines the structure, dynamics and spatial distribution of paramagnetic particles at an atomic level in any type of material at temperatures ranging from 4 to 300 K. In addition to solid substances, the apparatus also allows analysis of gels, liquids and biological samples.

CANAM

The CANAM project (Centre of Accelerators and Nuclear Analytical Methods) of the Institute of Nuclear Physics, Academy of Sciences of the Czech Republic, v.v.i., relates to the operation of particle accelerator and the equipment for analysis using nuclear methods in Řež, Czech Republic. Cyclotron U-120M is used for the study of nuclear reactions, preparation of radionuclides for research and manufacture of radiopharmaceuticals and is a unique source of fast neutrons. The electrostatic accelerator Tandetron 4130MC is used for the analysis of materials with ion beams and their modification using ion implantation. The experimental apparatuses installed on neutron radiation channels of the LVR-15 reactor (ÚJV Řež a.s.) are intended for structural and elementary analysis of materials with neutrons. All of these apparatuses are used extensively in national and international cooperation and in neutron physics the facility is included in the European project NMI3 – ACCESS to Large Facilities. The NPI with their accelerators

and apparatuses on the LVR-15 reactor covers a major part of requirements of the Czech scientific community, provides analytical and radiation services and allows training of new experts. The centre also maintains extensive contacts and bilateral cooperation with partners abroad in the solution of specific research problems.

Van de Graaff

Van de Graaff (accelerator HV2500) is a long-established proton accelerator situated in the premises of the FMP CU, Troja. This large infrastructure is being taken over (under an agreement between the interested institutions) by the IEAP CTU. The facility is currently used as a source of polarised neutrons for a polarised target (constructed jointly by experts of the FMP CU and SÚJV Dubna), as a source of accelerated charged particles for further application experiments based on experimental channels of the accelerator, and for the purposes of the Faculty of Nuclear Sciences and Physical Engineering (FNSPE) of the CTU. The facility is used as a source of charged particles and neutrons for the characterisation and detection tests of detection structures developed for experiments under CERN. The facility serves not only the current research programmes, including activities with SÚJV Dubna, but also new projects of the European Space Agency. The accelerator also plays a very important role in training for students as they encounter a wide range of related technical and scientific issues (vacuum, HV, magnets for bending beams of charged particles, ion sources).

Wind tunnels

These tunnels are owned by the Aeronautical Research and Test Institute in Prague –Letňany and are situated in two locations – the aerodynamic testing plant for low speeds (Prague 9) and high speeds (Prague 8). Both testing plants include a number of wind tunnels and other accessories (measuring and computing technology, testing plant equipment, etc.) essential for applied and basic research in aerodynamics and mechanics if fluids. The topics studied at these facilities fall under thermodynamics and mechanics of fluids and certain areas of energy, aeronautics, aerodynamics and civil engineering. The facility has 56 permanent employees, of which 31 research workers and 21 technical workers. The infrastructure is used by a total of 28 internal teams (under various research projects) and 5 teams of users from abroad. The number of users from among industrial companies is 28. The facility is included in the network of excellent European facilities EWA (European Windtunnel Association) and agreements on partnership under various projects have been signed with Airbus UK, KTH Sweden, Eurocopter France, Thales France, Airbus Germany, and Lidar UK. Two international projects (CESAR and NACRE) are coordinated by the ARTI owing to the technical equipment of the institute. Local cooperating institutions include UT Brno, CTU Prague, institutes of the Academy of Sciences of the Czech Republic, Škoda Auto, a.s., Škoda Electric, a.s., Škoda Energo, a.s., and PBS Velká Bíteš a.s. The bulk of the outcomes comprises results of specific tasks under individual implementation projects.

b Large infrastructures abroad with official membership of the CR

CERN

CERN is an intergovernmental organisation for research of elementary particles with headquarters near Geneva. CERN operates an extensive system of accelerators, including the world's largest accelerator – the so-called Large Hadron Collider (LHC). Scientific cooperation with CERN is coordinated by the Committee for Cooperation of the CR with CERN, whose members are representatives of cooperating institutions and representatives of the MEYS, MF and MFA CR. The Czech Republic is involved in a number of experiments carried out under CERN. The ATLAS experiment at the LHC is the most important in view of the scope and significance of the contribution of Czech teams. The ATLAS experiment in the CR involves cooperation of around 60 physicists, students, engineers and technicians from the Academy of Sciences of the Czech Republic, CU and CTU, who participated in the design and construction of certain parts of the ATLAS detector, development of the program facilities and preparation of the physics programme. The ALICE experiment focused on collision of heavy ions, which should provide information vital for verifying the current theories of the beginning of the space, is another experiment carried out at the LHC with participation of the CR. Similarly to the ESA or ESO, the membership in CERN provides our industrial companies with the opportunity to participate in tenders announced by CERN for contracts for equipment and services. A contact point for cooperation of Czech industrial companies with CERN was created in the CzechTrade agency. It is also owing to this agency that the CR is one of the most successful countries in obtaining commercial contracts.

Tevatron – Fermilab

Tevatron is an accelerator used for studies of collisions of antiprotons with protons situated in Fermilab near Chicago, the largest American elementary particle physics laboratory. The detector for the D0 experiment in Fermilab was constructed under international collaboration on this accelerator. The Czech Republic has been a member of this collaboration since 1996 and the CR contributed by processing the collected data in the Regional Particle Physics Computer Centre of the Institute of Physics. Around 15 scientists, PhD students and technicians are involved in the physical analysis of the data processed in this manner. Institutions from the CR contribute to the operation and maintenance of the observatory from funds of the MEYS INGO and Research Centres programmes. The experience gained from processing data for this experiment and their physical analysis is very important for the preparation of young scientists for the ATLAS experiment in CERN.

Pierre Auger Observatory

The Pierre Auger Observatory was constructed under collaboration in the Mendoza province in Argentina. The observatory specialises in examination of the spectrum and composition of the highest energy cosmic radiation. The Czech Republic has been a member in this collaboration since 1999 and the main material contribution of the CR was the production of 12 mirrors for a fluorescent telescope, each with an area of approximately 12 m^2. In addition to the telescopes referred to above, the observatory contains a network of land detectors distributed over an area of approximately 3000 km^2. Institutions from the CR contribute to the operation and maintenance of the observatory from funds of the MEYS INGO and Research Centres programmes. Approximately 20 scientists, PhD students and technicians are involved in the collection and analysis of data from fluorescent telescopes and modernisation of the observatory. The observatory is to be extended by a network of land detectors and fluorescent telescopes in the Northern hemisphere in the USA.

LSM/JOULE

The LSM/JOULE project (Laboratoire Souterrain de Modane/JOint Underground Laboratory in Europe, France) covers a major part of current physics carried out in underground laboratories (neutrino physics – double beta decay, neutrino oscillation; dark matter detection; measuring very low radioactivity levels; new detection structures in ultra-sensitive measurements; removal of radioactivity from the air and material samples, testing semiconductor technology). The underground laboratory Modane (LSM, France, 4800 m.w.e.) was established in 1982 as a facility for experiments requiring an extremely low background. The CR has been significantly participating on a long-term basis in the NEMO 3 and TGV II experiments. Preparation of significant extension of the existing LSM/JOULE laboratory with a total cost of EUR 15 million has been underway since the beginning of this year. This is a continuation of the TGV III experiment (double electron capture measured with pixel detectors), SuperNEMO (neutrino free double beta decay, 100 kg of enriched isotope), low background HPGe detector with a volume of 600 cm^3 and the COBRA experiment (double beta decay 116Cd using pixel detectors).

ESRF & ESRF Upgrade

Synchrotron radiation is essential for modern research in many areas of basic and applied research of new materials and molecular and biological structures. The European Synchrotron Radiation Facility in Grenoble (http://www.esrf.eu) is a source of the highest intensity synchrotron radiation in Europe. The CR has been officially involved in the ESRF since 1999 and is formally represented by the Institute of Physics, Academy of Sciences of the Czech Republic, v.v.i. The ESRF upgrade during the period 2009-2018 will provide users with new research opportunities, in particular in nanotechnologies, structural biology, fast processes, behaviour of substances under extreme conditions, and development of X-ray imaging methods.

ILL

The Max von Laue and Paul Langevin Institute in Grenoble (http://www.ill.eu) operates the most intensive stationary source of neutrons worldwide with connections to around 40 unique measuring facilities using neutron beams for modern experimental research in various scientific disciplines; in physics, chemistry, material sciences, biology, etc. The CR has been one of the 10 scientific partners of the ILL since 1999. Representation and administration of interests of the CR at the ILL has been entrusted to the Charles University in Prague, FMP. Long-term Czech participation at the ILL is of major significance for a stable access to modern methods using intensive neutron beams for the Czech scientific community. Finance is required for covering membership dues and additional costs.

ThALES (ILL 20/20 upgrade)

Facilities at the ILL are developed continuously with the aim to optimise parameters and thus facilitate the performance of experiments that could not be carried out so far and this significantly increases the scientific benefits for member states. Modernisation of the ILL facilities is now a subject of project ILL 20/20 (upgrade) under the ESFRI Roadmap. The FMP CU plans to construct a new generation triaxial spectrometer at the ILL under the ThALES project for research of low energy inelastic electron scattering. As a compensation, the ILL will provide a direct allocation (without a tender) of 50 days on ThALES over a period of 2 years following the final building approval to Czech teams and 2 years of training for 2 PhD students over and above the extent of the CR's current rights. Finance is required for a contribution to the spectrometer construction and additional costs.

ELETTRA – MSB

ELETTRA in Trieste is a modern third generation synchrotron with 22 optical paths. The energy range of synchrotron radiation (120 eV - 8 keV) makes ELETTRA complementary to the ESRF in the field of low energies. The CR constructed the local Materials Science Beamline (MSB), which is administered by the Charles University in Prague, FMP in cooperation with the Institute of Physics, Academy of Sciences of the Czech Republic, v.v.i. The CR is the only country from the former Eastern bloc (besides Russia), which now has its own optical path at the synchrotron. The MSB provide measuring time on a unique cutting-edge apparatus for photoelectron spectroscopy for interested parties from the wide scientific community.

ESO & Centre for Cooperation with the ESO – ESA – NASA

The European Southern Observatory (hereinafter only as the "ESO") is a non-governmental European organisation for astronomic research in the Southern hemisphere. The organisation has 13 members including the CR. The ESO operates astronomic telescopes situated in La Silla and on the Paranal Mountain in the Atacama desert (Chile). The mission of the ESO is to implement under international cooperation first-class scientific research, put into practice major astronomic projects, develop new apparatuses, focus on new technologies, develop European cooperation, participate in educational programmes and create programmes attractive to the general public. In addition to its participation in space research using the largest telescopes and the access to the ESO – ESA – NASA infrastructure, the CR has access to cutting-edge technologies with application potential in many other scientific disciplines and opportunities for obtaining unique contracts for the manufacture of high-precision surfaces, electronic control systems, remote control systems, optical assemblies and high-precision mechanical systems. Scientific cooperation with the ESO is coordinated by the Institute of Astronomy, Academy of Sciences of the Czech Republic, which has also established the Centre for Cooperation with the ESO – ESA - NASA. All research centres specialising in astronomic research with a compatible focus at the required level may take part in research programmes to which the Czech Republic has access through this Centre. Similarly to the ESA, the ESO also provides opportunities for consortiums of major research facilities and industrial companies to participate in contracts for their own facilities. The CR will also soon become involved in the optional ESO programmes and thus will extend the opportunities for participation of entities from the CR in individual projects. The Institute of Astronomy, AS CR and the Plasma Physics Institute, AS CR also participate in the project focused on preparation of the EST (European Solar Telescope) construction, which will support observations carried out with the ALMA interferometer, which is also one of the ESO projects.

Table:

Large infrastructures in the CR	Brief description	Infrastructure type	Year of completion
ELI	Extreme Light Infrastructure Interaction between radiation and mass under ultrarelativistic regime	ESFRI	Major project OP RDI
PALS	Unique high-performance laser	National	Existent
MLTL	Assembly of unique apparatuses for magnetism and low temperatures	National	Existent
LNSM	Comprehensive equipment for the research of functional nanomaterials and semiconductor nanostructures	National	Existent
SAFMAT	Laboratory for characterisation of functional nanostructure materials	National	OPPC project
CANAM	Accelerators and experimental equipment for interaction between materials with ions and neutrons	National	Existent
Van de Graaff	Source of charged particles and neutrons	National	Existent
Wind tunnels	Unique facility for the research of ultrasonic and subsonic flow	National	Existent

Large infrastructures abroad with participation of the CR	Brief description	Infrastructure type	Year of completion
CERN	European Organisation for Nuclear Research; facilities for research of elementary particles	International organisation	Existent
Tevatron Fermilab	Facility for studying collision of protons with antiprotons	International experiment	Existent
Pierre Auger Observatory	Facility for studying the highest energy cosmic radiation	International experiment	Existent
LSM/Joule	Laboratory for neutrino physics	International experiment	Existent
ESRF & ESRF Upgrade	Source of intensive synchrotron radiation	International organisation	Existent, upgrade under the ESFRI
ILL	Intensive stationary source of neutrons	International organisation	Existent
ILL 20/20 Upgrade (ThALES)	Triaxial low-energy spectrometer for the ILL upgrade	International experiment	upgrade under the ESFRI
ELETTRA MSB (Material Science Beamline)	The Czech Material Science Beamline at the ELETTRA synchrotron in Trieste	International organisation	Existent
ESO (European Southern Observatory) & Centre for the ESO – ESA - NASA	Unique assembly of astronomic apparatuses for studying the southern sky	International organisation	Existent, upgrade under the ESFRI

3.4 Promising Projects

CEITEC

CEITEC is a large RDI project aimed at integrating the best scientists in material research and research of live nature from a number of universities and the Academy of Sciences of the Czech Republic. Conditions for interdisciplinary integration and cooperation are created. The Central European Institute of Technology in Brno project focuses on establishing a first-class centre for biotechnologies and advanced materials. The centre will facilitate concentration of currently fragmented personnel and equipment capacities in the region's research and development and thus ensure a high level of effective resource utilisation. The research will focus on progressive materials, namely ceramic materials in view of their utilisation for joint replacements and dental applications, electrochemical applications and applications in structural elements. Special attention is paid to the study and development of nanostructures and their layering for the development and manufacture of advanced materials. The study and development of metal materials and alloy and exploitation of their properties in practical applications is another area of interest. Significant outcomes may be expected from the study of superconductive materials.

ESS

ESS - European Spallation Source - Scandinavia in Lund (Sweden), http://ess-scandinavia.eu/, will be a pan-European facility (complementary to the ILL) for multidisciplinary research of advanced materials using neutron scattering methods after 2020. Research areas where the ESS will find application include material sciences, nanosciences, chemistry, molecular biology, biotechnology, pharmacology, energy and microelectronics. The spallation source (ESS) will produce intensive neutron beams using the so-called spallation process instead of the conventional nuclear reactor, which produces continuous beams. Methodologies using pulse and continuous neutron beams complement each other in many aspects. The CR's participation in the ESS is highly desirable to maintain the excellent standard of Czech scientists in the use of unique neutron scattering methods in modern material research. Finance is required during the period 2010-14 for effective participation of the Czech neutron community in the construction phase, providing training for young Czech scientists and students in the form of internships in the existing laboratories with spallation sources. Construction of a unique neutron diffractometer for studying materials in extreme conditions in the form of an in kind contribution to the ESS infrastructure has been negotiated with the ESS management. The project will be guaranteed by the NPI AS CR and the FMP CU.

XFEL

XFEL X-ray Free Electron Laser, which is currently under construction in Hamburg (http://www.xfel.eu/), is a facility that will supply 107 times more intensive X-ray radiation than the radiation currently attainable from femtosecond flashes. This will allow the performance of experiments that could not been carried out until now, and the solution of new issues in nanosciences, structural biology, physics of solid substances and femtochemistry, as well as material sciences and plasma physics. Czech participation is highly desirable for the Czech scientific community to maintain the excellence of Czech scientists in the application of unique X-ray scattering methods in modern material research. Czech scientists from various disciplines therefore can be involved in the development of apparatuses, detectors, X-ray optics and control systems for the XFEL. Research teams could also take part in planning experiments at the XFEL. Finance is required during the period 2010-14 for effective participation of the Czech neutron community in the construction phase and ensuring training for young Czech scientists and students in the facilities in Hamburg.

SPIRAL2

SPIRAL2 (http://www.ganil.fr/research/developments/spiral2/index.html) is a newly planned facility under the ESFRI, which should extend the most prominent French nuclear physics laboratory GANIL (http://www.ganil.fr). SPIRAL 2 is to ensure worldwide competitiveness even in 2015, when the facility should reach its planned specifications. The facility will produce mainly radioactive beams (but naturally also intensive stable ion beams) using the on line isotope separation method ISOL. The existing cooperation in research of properties and structure of light and medium-weight nuclei between the NPI, Academy of Sciences of the Czech Republic and GANIL has so far been partially supported by the agreement AVČR-IN2P3. Development and construction of the SPIRAL 2 facility is currently under way. This facility is to ensure worldwide competitiveness of the GANIL laboratory even in 2015, when its operation should reach its planned specifications. The SPIRAL2 laboratory will be equipped with unique apparatuses for neutron production and nuclear astrophysics.

FAIR

FAIR (Facility for Antiproton and Ion Research) (www.gsi.de/fair/index_e.html) is a unique experimental assembly, which will allow the performance of experiments with antiproton and heavy ion beams. This new project implemented within the premises of the GSI Darmstadt research centre (Germany) is organised as an international and predominantly European research centre included in the ESFRI. FAIR contains an accelerating assembly comprising a number of new accelerators, accumulation rings and new experimental equipment. This assembly will provide proton, antiproton, heavy ion and exotic radionuclide beams for experimental purposes with energies up to 35 Ge, achieving unsurpassed intensity and allowing studies of physical processes under extreme conditions, which have so far been unachievable under experimental conditions. Czech physicists have been cooperating with colleagues from GSI for almost 20 years. They participate in the TAPS, HADES and CERES experiments.

4 Energy

4.1 Current Status

Energy plays a major role in people's lives these days as the requirements of dynamically developing societies cannot be satisfied without ensuring stable and long-term energy supply. In addition, energy has an extensive impact on the environment. In 2007, the consumption of primary energy in the CR was covered by a mix of different sources (61% steam power plants, 21% nuclear power plants, 12% hydraulic power plants, 5% gas-steam and combustion power plants, 1% wind farms). Varying tendencies in the production and consumption of electricity are becoming evident in the CR – savings in consumption (the average growth of the economy from 2000 was 4.5%, yet electricity consumption only increased by 2% per annum), as well as a major increase in production from smaller renewable sources (photovoltaic cells, biomass) and the consequently increasing demands for the transmission system.

Due to its strong links with the industry, research in energy copies roughly the industrial structure of companies operating in the relevant area. Energy research addresses mainly issues relating to conventional energy, nuclear energy and lately also renewable sources and the transmission system. Energy research in the CR is scattered among numerous institutes (universities, institutes of the Academy of Sciences of the Czech Republic and corporate scientific institutes).

The need for the development of modern large infrastructures (LIs) in energy significantly exceed the capacity of individual institutes and even the capacity of the entire CR. Membership in the EU has brought the opportunity for effective concentration of resources by participating in pan-European projects. Despite this, the development of scientific and innovative basis in the CR and systematic participation of Czech companies in the construction of local or European LIs should remain our aim in this respect. In addition, our efforts should not be limited to trips of our experts abroad. Basic research should be carried out at facilities in local institutes with participation of scientific and technical experts from abroad (reciprocity of cooperation, establishing laboratories in the CR).

Energy LIs can be divided into a few areas: fission reactors (of various generations), facilities focusing on nuclear fusion (various methodologies), facilities focusing on conventional energy and facilities focusing on renewable sources.

The following overview illustrates the current status of national large energy infrastructures:

Reactors LVR-15, LR-0

Reactors LVR-15 and LR-0 are situated in the research centre **Centrum výzkumu Řež, s r.o.** Reactor LVR-15 was constructed and put into operation in 1957 as an experimental facility for the purposes of reactor and neutron physics. The reactor has been modernised a number of times (the latest modernisation took place in 2007) to its current operating output of 10 MW. A series of horizontal and vertical channels for released neutron beams, high-pressure loops and the reactor's thermal chamber are used for experimental purposes. For experimental purposes, the reactor is fitted with pneumatic mail for transporting irradiated samples and hot cells. Irradiation experiments are carried out mainly to study changes in physical and chemical properties of materials caused by radiation. Medical and biological research is also carried out using the released beam of epithermal neutrons. Horizontal channels are used for basic and applied research. The facility has 115 permanent employees, 23 of which are scientists. There are 11 teams of external users and about 7 teams of users from abroad (Slovakia, Israel, Latvia, Russia, Poland, France, Germany, Italy, Greece) permanently use the offered facilities. The reactor's capacity is also used by a number of user teams from the industry. Research carried out on the equipment of the LVR-15 reactor focuses mainly on the application sector.

The LR-0 reactor was put into operation in 1972 and the last modernisation was completed in 2008. The experimental programme focuses on reactor physics of active zones of pressurised water reactors, storage racks, model experiments on VVER-1000 and VVER-440 reactors carried out to determine the spectra of mixed photon and fast neutron fields (inputs for determining the radiation load for internal structural parts and pressurised vessels and precision of estimated residual life of components of pressurised reactor vessels), experiments in reactor and neutron physics for computing code validation, and experiments carried out to verify certain parameters of new types of active zones for advanced reactors intended for utilisation and involvement in international cooperation in development of new technologies for fuel cycle termination (Molten Salt Reactor). Only 5 facilities of this kind operate in Europe. Measurements help to improve nuclear safety and effectiveness of operation of nuclear plants and storage facilities of spent nuclear fuel. 11 of the 25 permanent employees of this facility are scientists. The facility is permanently used by 3 internal research teams and 2 additional teams from abroad.

Tokamak COMPASS

This facility was transported from Culham Science Centre in Great Britain and was placed in the newly constructed building of the Institute of Plasma Physics, Academy of Sciences of the Czech Republic, v.v.i. in the premises "Na Slovance" in Prague. It is a facility for experimental study of hot plasma physics in magnetic fields. COMPASS is a facility with geometry similar to that of the ITER tokamak and of other two large European facilities (ASDEX Upgrade in Garching near Munich and the joint European tokamak JET). The scientific programme arises from current needs of the international project ITER, which should demonstrate a successful technological solution for thermonuclear fusion. In view of the similarity of the magnetic configurations of ITER and COMPASS, a decision was made to focus on two main topics – study of boundary plasma and interaction between electromagnetic waves and plasma. Partner organisations in the Czech Republic are the FMP CU, FNSPE CTU in Prague, the Institute of Physics, Academy of Sciences of the Czech Republic, v.v.i., J. Heyrovský Institute of Physical Chemistry, Academy of Sciences of the Czech Republic, v.v.i. and ÚJV, a.s. At the international level, the COMPASS project is coordinated by EUROATOM. Research is carried out by more than 4 internal teams, in particular in material research, and a number of international cooperating teams (France, Austria, Belgium, Italy, Great Britain, Georgia, Poland, Bulgaria, Russia, Hungary, Portugal). Two industrial companies currently cooperate with the project (Škoda výzkum, s.r.o. and Vítkovice – Výzkum a vývoj, s.r.o.). The activities are expected to develop further as the volume of industrial cooperation grows. Tokamak COMPASS has 34 employees in total (22 of whom are scientists).

Teaching reactor VR-1

The VR-1 reactor was constructed in 1990 at the FNSPE CTU in Prague. Due to its low output, this reactor is mainly use for tuition (4-5 PhD students, 6-8 Master students and 3-5 Bachelor students per year), for studies of nuclear safety and for development of control systems for nuclear facilities. 16 employees work on the VR-1 reactor (11 of whom are academics).

The ESFRI Roadmap 2008 of European large infrastructures lists additional projects in energy at various phases of implementation (Jules Horowitz high-flux reactor JHR; International Fusion Materials Irradiation Facility IFMIF; High Power Energy Research Facility HiPER, MYRRHA). The so-called renewal of the ESFRI Roadmap for energy in 2010 is currently being discussed under the ESFRI process.

No large infrastructure of European or at least national significance currently exists in R+D in conventional energy or renewable sources in the CR. On the other hand, many entities (university faculties and institutes, institutes of the Academy of Sciences of the Czech Republic, privately owned companies) cover or plan to cover the entire scope of R+D issues in conventional energy and renewable sources (highly efficient modern coal blocks including technologies for capture and storage of CO_2 emissions, smart grids, utilisation of biomass in energy, wind and solar power, geothermal energy, fuel cells, superconductivity, etc.). These research centres are typically small (usually with 10-20 scientists) and operate smaller existing facilities (investments approximately CZK 1 million). On the other hand, these facilities typically offer intensive tuition for students (10-20 PhD students per 5 years per facility), which proves that they are attractive for students. The available materials suggest that individual facilities are active in their efforts to obtain support from the OP RDI or regional OPs (such as the Centre for Research and Utilisation of Renewable Energy Sources – CVOZE; Centre for Research of Energetic Exploitation of the Lithosphere – CVEVL; Sustainable Energy; Research Centre for Production of Energy and Biofuels from Renewable Sources). This area of research also typically has very strong ties to industrial companies. International cooperation tends to occur mainly at a regional level (a few particular

partners from abroad) and cooperation with joint technological initiatives and European technological platforms is not satisfactory (low level of representation of the CR in technological platforms).

The analysis of the current status quo clearly shows that development of experimental research platform in the CR in line with international or European directions in the development of R+D is necessary (such as increased investments in national experimental and development facilities, greater participation of foreign experts in R+D carried out in the CR). In the case of nuclear sciences, development of local infrastructures is needed – LVR-15, LR-0, Tokamak COMPASS-D reactors and the teaching reactor VR-1. Centrum výzkumu Řež, s r.o. (LVR-15, LR-0 reactors) works in close association with the industry (ČEZ) and European nuclear structures such as OECD/NEA. The local Tokamak is vital for proper participation of Czech facilities in the thermonuclear fusion project ITER. The VR-1 plays a major role in basic training of young experts. Access rights arising from free competition of projects – the so-called open access need to be strictly applied in all local LIs for both, Czech and foreign users. The current lack of a major LI in the CR needs to be addressed in conventional energy and renewable sources by gradual construction of experimental facilities and connecting individual institutions in order to promote coordinated cooperation. Significant improvement in the participation of Czech facilities in international cooperation and ESFRI initiatives is also essential.

4.2 SWOT Analysis

Strengths

- Science and research in energy in the CR covers all aspects of energy production and utilisation;
- Strong tradition in conventional fossil energy and nuclear energy;
- Close links to the industry;
- Good scientific results achieved previously;
- Ensured tuition for students (in all main fields of energy including renewable sources).

Weaknesses

- Significant fragmentation of research in conventional energy, renewable sources and smart grids;
- Non-existence of large and modern large infrastructures in conventional energy, renewable sources and smart grids;
- Limited cooperation among facilities;
- Excessively competitive environment preventing the creation of distributed infrastructures and development of closer cooperation;
- Life of reactors LVR-15 and LR-0, high demands on investment and operation associated with modernisation of nuclear research infrastructures.

Opportunities

- Strategic area of key importance, especially in the upcoming years;
- Priorities specified in the National Energy Concept; opportunity and necessity to respect these priorities;
- Opportunity to participate in ongoing European projects (such as ESFRI) and established platforms; making use of approaches and experience from abroad;
- Opportunities for involvement of SFs, in particular the OP RDI; these investments can help in the construction of facilities at a national or European level with ties to international research.

Threats

- Potential lack of human resources anticipated in energy after 2015 may also have a negative impact on science and research in this area;
- Problems with ensuring Open Access to certain large infrastructures;
- Failure to involve all research groups active in R+D in the process of research facility development;
- Lack of interest in greater cooperation and eliminating fragmentation among facilities in certain fields;
- Intensive cooperation with facilities abroad results in migration of excellent researchers without any certainty of their return to their original facility.

Proposed solution

A national integrated LI of research reactors LVR-15 and LR-0 (Centrum výzkumu Řež, s r.o.) will be established in the field of fission reactors. The reactors need to be continuously modernised (in cooperation with the MIT, ÚJV a.s., ČEZ) and truly open access must be ensured for local and foreign users (an international panel of scientific experiment and project assessors, compulsory grant system as a support for projects from other facilities, management and scientific positions awarded through international selection procedures, etc.). As the currently ongoing JHR project (operation to commence in 2014) appears to be significant for new nuclear fission technologies, we recommend supporting participation of the CR in this project (the CR is represented by Centrum výzkumu Řež, s r.o.). The Sustainable Energy project (entered in the SF competition) offering research in new reactor technologies with an impact on Czech regions (Plzeň) should be supported as a secondary priority.

In thermonuclear fusion, reasonable level of support needs to be provided for fusion technologies addressing ambitious challenges and offering intensive international cooperation, impact on numerous publications and basic research results but without any direct impact on the practical energy at least over the next 20 years. In addition, groups focusing on fusion research are not highly differentiated or horizontally extended within the CR. Therefore, we recommend providing support for the national LI COMPASS tokamak and the planned ITER under the same conditions as in the case of reactors (international scientific committee, compulsory grant system to support projects from other facilities, etc.).

The HiPER (currently in the design phase, construction is to commence in 2015 and operation is to commence in 2018) needs to be supported as a separate LI abroad.

Modern utilisation of fossil fuels (including capture and storage of CO_2 emissions) and waste, and major development of renewable sources (second generation liquid biofuels, photovoltaics, geothermal energy, smart grids, hydrogen energy) appear as highly important sources for the near future (10-15 years) of the Czech energy policy. Experimental R+D opportunities in non-nuclear energy need to be improved. This could be achieved by launching two initiatives ("Progressive Technologies and Systems for Utilisation of Fossil Fuels and Waste", "REWESAG – Renewable Energy Sources and Electrical Grids") aimed at uniting major facilities throughout the CR (such as the CTU in Prague, UT Brno, VŠB-TU Ostrava, UWB in Plzeň, ICT, institutes of the Academy of Sciences of the Czech Republic, EGÚ Brno, ČEZ). Coordinators and subsidy beneficiaries should be facilities outside Prague (for example in Ostrava, Brno, Plzeň). New initiatives should facilitate close coordination of activities and specialisation and initiation of cooperation with already existing European platforms. Once the preparatory phase has been completed (in 2013) the emergence of major joint research projects in the form of direct participation in a selected European project or a proposal for constructing an experimental LI in the CR can be expected. If a local LI is established, the synergy with the RDI OP will need to be utilised.

4.3 High-priority Projects

LVR-15, LR-0

The largest local infrastructure in reactor physics with a significant share of cooperation with the industry and international activities. Continued operation and further development of this infrastructure need to be ensured for the purposes of research in the CR (in particular MIT, ČEZ, ÚJV). The infrastructure is a part of the premises of Centrum výzkumu Řež, s r.o.

JHR

JHR – Jules Horowitz Reactor is a European project (with major participation of CEA, EDF and AREVA – 80% in total), in which CR has a 2% share. The total reference project costs are EUR 500 million. The CR is represented in the JHR by Centrum výzkumu Řež, s r.o.

COMPASS and ITER

The COMPASS tokamak is a local large infrastructure. It is a facility for experimental study of hot plasma physics in magnetic fields. COMPASS is a facility with geometry similar to that of the ITER tokamak and additional two large European facilities (ASDEX Upgrade in Garching near Munich and the joint European tokamak JET). The ITER project is a planned international project with European participation relating to thermonuclear fusion. The CR is represented by the Institute of Plasma Physics, Academy of Sciences of the Czech Republic, v.v.i.

HiPER

HiPER is a European project. The facility if in its preparatory phase and its construction is planned in Great Britain (operation is to commence in 2018). It is a laser-controlled fusion demonstrator. The CR is represented by the Institute of Physics, Academy of Sciences of the Czech Republic, v.v.i.

Table:

Name of large infrastructure	Brief description	Infrastructure type	Year of completion
Reactors LVR-15, LR-0	Fission reactors	National	Existing
JHR	New generation fission reactor	ESFRI	2014
Tokamak COMPASS and ITER	Hot plasma in magnetic fields – thermonuclear fusion	National and international	2009, 2020
HiPER	Laser-controlled fusion demonstrator	ESFRI	2018

4.4 Promising Projects

Sustainable Energy

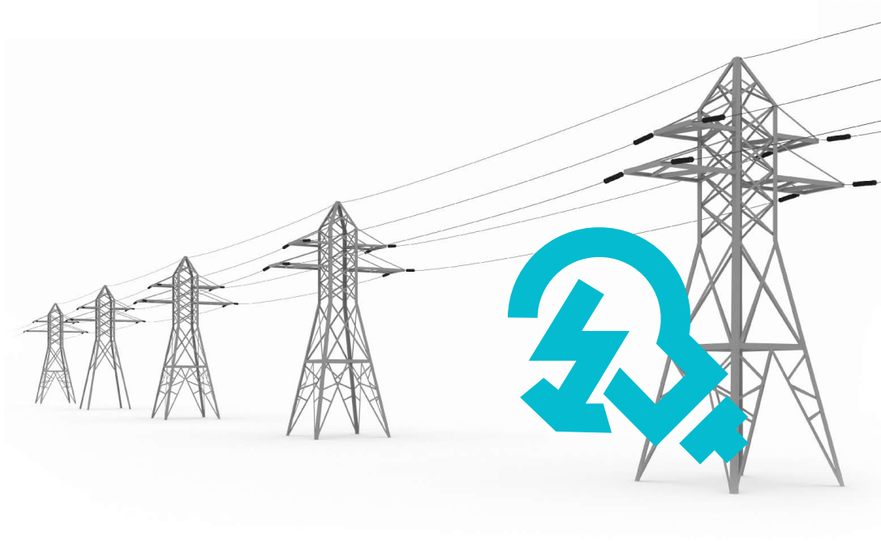
This project focusing on a new generation fission reactor could be implemented through the OP RDI.

Centre for Research of Energetic Exploitation of the Lithosphere (CVEVL)

This project focusing on the utilisation of geothermal energy could be implemented through the OP RDI.

REWESAG – Renewable Energy Sources and Electrical Grids

This project focuses on utilisation of renewable sources and biomass.



5 Biomedicine

5.1 Current Status

Biomedicine or "BioMedical Sciences" (BMS) encompasses a very broad group of scientific disciplines from systematic biology and basic and clinical research to the development of new biomedical and physical technologies. The worldwide development of biomedicine is highly dynamic because it directly incorporates new biological findings in the existing biopharmaceutical technologies. Explosive increase in the level of knowledge and results of the latest studies lead in this field to the emergence of new interdisciplinary fields and links between the existing fields of research. Fields with particularly dynamic development include functional genomics, bioinformatics, imaging, molecular structure analysis and translational medical fields, which are aimed at development of individualised therapeutic procedures. Bioinformatics are currently required to create structures for processing large volumes of data generated across all BMS disciplines and for their assessment. Functional genomics use the identified sequences of the human and other genomes to examine the functions of individual genomes in organisms and identify potential therapeutic objectives. Bioimaging and structural biology create new technologies for example for monitoring the function and location of biomacromolecules in entire organisms or for analysing the structure, interaction and function of individual molecules.

Until recently, the biomedical community in the Czech Republic has strived to cover as many fields in biomedicine as possible and this has logically resulted in maintenance or establishment of scientific groups, institutions or other entities striving to study newly emerging fields without the existence of the essential critical mass for the development of the relevant scientific discipline. This causes problems in terms of expertise, as well as finance, as requirements for machinery and technologies often repeat, although this equipment could be utilised better and could be at a level of cutting-edge technology if it were concentrated in an expert infrastructure with open access. This does not involve separate apparatuses but rather technologies and technological units, which can only develop if the relevant large infrastructure reaches a certain size with regard to its material but also personnel resources.

Many research institutes in the CR focus on an excessively broad range of scientific issues. Certain level of fragmentation is obvious even in the basic building blocks of the Czech science – in scientific institutions (research institutes, faculties and research centres of universities). Scientific centres financed through grants attempt to address this fragmentation to a certain extent. However, these centres are virtual and so far practically no large infrastructures concentrating and developing specific know-how and offering open access for its utilisation have been established. Interdisciplinary cooperation leading to the emergence of new fields or projects is rare. Nothing that could be described as the so-called large infrastructure currently exists in biomedical research in the CR. The bank for clinical samples owned by the Masaryk Institute of Oncology in Brno is the only exception.

Despite all problems listed above, a number of major research centres with a high concentration of very progressive methodologies at a European level exist in the CR. In basic medical research, these include in particular the premises of biomedical institutes of the Academy of Sciences in Prague – Krč with the Institute of Physiology, Institute of Microbiology, Institute of Experimental Medicine and Institute of Molecular Genetics. The broad spectrum of modern methodologies available to these institutes allows them to participate in the solution of numerous scientific projects under the EU Framework Programme. The Czech Republic's leading clinical research facility – the Institute of Clinical and Experimental Medicine (IKEM) specialising in transplantation medicine and cardiac surgery is also located in Prague – Krč. Close cooperation between IKEM and facilities of the Academy of Sciences in Krč exists in particular in imaging technologies based on magnetic resonance.

The link to the application sector is often established through small companies, which do not possess any actual know-how in the relevant field or intellectual property and take part in certain scientific centres purely due to the requirement of the company's involvement. The significance of a vast majority of connections with Czech companies is limited to the local conditions.

Attempts to involve already existing or established scientific centres in the European scientific community have lately been rather frequent especially due to the emerging European ESFRI Roadmap and other European scientific initiatives. There have also been efforts to establish centres of excellence, which could form a basis for large infrastructures with concentrated know-how in one or a few selected fields and which (if they receive sufficient support from the state) could accumulate the critical mass of scientific resources (personnel and technological) required not only for maintaining the relevant expertise, but also for its further development. These centres have the potential to have truly international significance.

5.2 SWOT Analysis

Strengths

- There is a sufficient intellectual capacity, experience and human resources for a number of technological units;
- Individual groups work on their participation in the ESFRI Roadmap consortia;
- Individual groups achieve excellent scientific results and take part in determining the direction of further development of scientific disciplines at least at the national level.

Weaknesses

- Fragmentation of infrastructures;
- Insufficient links between individual infrastructures and frequent duplication;
- Non-existence of a large biomedical infrastructure in the CR;
- Few potential national large infrastructures are connected to the ESFRI Roadmap consortia;
- Research is very heterogeneous and it is therefore difficult to find a single uniting topic;
- Numerous local interests and particular objectives lead to the establishment of small technological or disciplinary units or a multitude of scientific groups located at various facilities with minimal ties between them;
- Isolated groups can rarely contribute to excellent development of the field/group/facility.

Opportunities

- There is an opportunity for creating platforms with advanced technologies and research and incubators for progressive or new scientific disciplines;
- Establishment of large infrastructures with specialised know-how and connection to the international environment such as the major European ESFRI projects opens the opportunity for obtaining top international scientists and attracting young promising Czech scientists back from long-term stays abroad;
- Involvement of top scientific centres in our national environment will bring new scientific culture and more intensive international cooperation;
- All of these effects will help us profile our research and create conditions necessary for establishing applied research centres in future; there are currently no high-quality resources for first-class applied research in the CR and these resources require long-term preparation.

Threats

- The absence of a uniform and long-term concept of support for R+D provided by major political parties;
- Without adequate level of support, there could be a lack of personnel at all levels, although personnel capacities are available;
- Lacking results in application research applied in the industry – we have a small industrial basis, which is capable of applying results from these infrastructures;
- Insufficient experience in management of large infrastructures;
- Non-existence of a communication platform for BMS;

Proposed solution

Results of research, efficiency and cost effectiveness in the CR can be improved by concentrating know-how in large infrastructures, which should be located within scientific (and technological) centres or campuses to ensure more intensive disciplinary and interdisciplinary cooperation, create conditions for the development of excellent groups, and facilitate participation of experts from abroad in our institutions. An accompanying programme should be created for the defined infrastructures not only to support training of new scientific talents but also to facilitate the participation of Czech and international scientists in our, if possible, unique programmes through the "open access" principle. Creation of this type of sub-programme should facilitate two types of access for scientific capacities: a) bring new know-how from abroad and establish it here; b) join us to make use of our know-how – we will help you solve your scientific problems under cooperation. In particular the second option has the potential to open our relatively closed scientific community to the international scientific community. In addition, scientists should have not only scientific but also economic reasons to strive for the opportunity to work in unique infrastructures. The potential for applied research needs to be first established (currently this area only involves copying technologies or even their purchase and establishment). A few companies operating in Brno, which draw on the tradition of development and manufacture of electrone microscope, are a rare exception. Production of nanofibres for medical purposes in the Liberec based company Elmarco is another positive example. The parameters for corporate participation in applied research need to be defined in a manner allowing ideally also international companies to participate in applied research as they have high levels of expertise in specific fields and the potential to truly advance our scientific activities. Establishment of a communication and organisation platform for BMS is essential.

5.3 High-priority Projects

Bank for Clinical Samples/BBMRI

The Bank for Clinical Samples is an already existing large infrastructure established and managed by the Masaryk Institute of Oncology (RECAMO). The facility attempted participation in the ESFRI - BBMRI and this Czech centre has recently been certified by the BBMRI steering committee as an associated structure. In future, the **Bank for Clinical Samples will become the Czech coordinator of the Czech part of the pan-European research infrastructure BBMRI – Biobanking and Biomolecular Resources Research Infrastructure**. The Masaryk Institute of Oncology not only organises a unique bank of clinical samples of tumours, but also possesses a unique combination of technologies and knowledge necessary for implementation of translational research and its clinical application including clinical trials. The facility has the know-how required for the performance of translational research in cellular biology, molecular oncology and applied molecular oncology. In biobanking, the biobank of the Masaryk Institute will allow access to clinical samples or their analyses also under the BBMRI to ensure that the analysis of archived material facilitates further development in the prevention, diagnostics and therapy.

BIOMEDREG

The project consortium BIOMEDREG – Institute of Molecular and Translational Medicine was established by the Palacký University in Olomouc (beneficiary-coordinator), the Institute of Organic Chemistry and Biochemistry, Academy of Sciences of the Czech Republic, v.v.i. (ÚOCHB), Faculty Hospital in Olomouc and the Institute of Chemical Technology (ICT) in Prague.

The aim of the planned project is to obtain and apply new findings in basic and translational medicine and to establish a new large infrastructure – the Institute of Molecular and Translational Medicine, which will be established using the existing expertise of project partners. Specific objectives of the project are as follows: 1/ study of the emergence and treatment of tumours, inflammations and rare diseases; 2/ creation of a national platform for chemical biology and development of experimental medicines and biomarkers; 3/ identification of new diagnostic procedures leading to individualised therapy. In order to attain the objectives listed, above, BIOMEDREG will make use of close cooperation among the members of the project consortium: i) the largest regional hospital – the Faculty Hospital in Olomouc (FNO), which will ensure access to clinical material and early verification scientific studies (proof-of-concept); and ii) internationally recognised chemical and biochemical centres ÚOCHB and ICT. Both institutions will directly participate in the scientific programme and complement the project mission very well. They provide unique chemical libraries of substances, know-how for the BIOMEDREG centre in Olomouc, and a unifying focus on biological chemistry applied in pathogenetic signal paths and research of biologically active substances. The BIOMEDREG infrastructure will be placed in an eligible region if the Czech Republic – in the Olomouc region (Olomouc) with easy access from major national biomedical and chemical educational institutions. BIOMEDREG has the potential to become a partner institution under the pan-European EATRIS project under the ESFRI Roadmap.

5.4 Promising Projects

INFRAFRONTIER

As the human genome sequence is completed, biomedical research faces a major task of determining the function of all genes and their protein products and determining the role of non-coding genome elements. Functional genomics in mammal models not only identifies, but often even verifies gene functions studied at the less complex cellular level. This makes this discipline essential for identification of pharmaceutically important target genes. Once such gene is identified, its effects are once again verified on an animal model (typically mice) created for these purposes using targeted gene manipulation. Programmes standardising the conditions for phenotyping and data collection have emerged over the last few years; these included EUMORPHIA and EUMODIC. The European consortium **INFRAFRONTIER** draws on these programmes and organises a network for system phenotyping of mouse mutants. ***The Czech Centre for Phenogenomics (CCP)* established as part of the BIOCEV centre of excellence** has become a full member of this consortium and will participate in systematic standardised functional annotation of genes (description of gene function) under this European consortium, while at the same time providing know-how and facilities for economic analysis of models created and studied in Czech institutions.

The Czech Centre for Phenogenomics (CCP) will create and analyse animal models (mouse, rat) and the obtained results will be subsequently used for understanding the principle of development of diseases in humans and their effective treatment. The research programme based on the recognised know-how of scientific groups in institutes of the Krč Academy (in particular FGU and UMG) will be built on a number of pillars, which can jointly be referred to as "phenogenomics". These pillars include in particular functional and comparative genomics in combination with functional genetics and genetic engineering. The aim of this project is to create an expert centre for phenogenomics containing all logistic units necessary for its effective use by specialised scientific groups: creation of mutant mouse and rat models, their cryogenic archiving and distribution, preparation of models for experiments and phenotyping, actual phenotyping, data analysis and providing data to international bioinformatics centres. The CCP will provide facilities to scientists from the CR and abroad in line with the open access principle and will initiate cooperation clusters between INFRAFRONTIER and other ESFRI programmes, such as Euro-Bioimaging, EU Openscreen, EATRIS and others to ensure that the results of their research are used effectively.

Euro-BioImaging

The **Euro-BioImaging** consortium – a centre for imaging methods will provide access to cutting-edge imaging technologies across a wide spectrum of biological and medical applications from molecules to patients. The centre will be organised as a pan-European distributed large infrastructure. The infrastructure will be newly formed and some of its existing parts will be reconstructed to ensure that a major part of its capacity can be made available to external users. In terms of methodology, the infrastructure focuses on advanced light microscopy in conjunction with electron microscopy and medical imaging. A harmonically coordinated infrastructure facilitating the development of first-class imaging technologies, access to and dissemination of developed technologies including training will be created. In the long-term perspective, the infrastructure will allow imaging molecules in their natural environment in a live cell or tissue and the outputs will be used in basic research, diagnostics, therapy and in development of new drugs. Timeframe: preparatory phase 2010-2012, construction phase 2012-2017, operation from 2013. Official pages: http://www.eurobioimaging.eu. The Czech part of this infrastructure will form a part of the BIOCEV centre. The existing facilities for light and electron microscopy are currently concentrated in institutes of the Academy of Sciences in Krč, and the Institute of Clinical and Experimental Medicine in Krč has the best equipment for magnetic resonance imaging in the Czech Republic (apparatus 3 Tesla and 1.5 Tesla for clinical research and apparatus 4.7 Tesla for research of animal models).

INSTRUCT

This large infrastructure for structural biology is being established in two centres with different, yet complementing specialisations. Firstly, it is the Centre for Molecular Structure in conjunction with the Structural Biology and Protein Engineering programme planned under the **BIOCEV** project. The infrastructure will focus on X-ray diffraction techniques, biophysical characterisation and mass spectrometry. It has reserved the position of the national access point for the Integrated Infrastructure for Structural Biology under the European INSTRUCT consortium. In addition to providing access to its own equipment and expert supervision and service, the infrastructure will implement its own research programme. This research programme will include the issue of enzymes for biotechnological and medical application, study of the structure and function of structure molecules in cells and nucleic acids, inhibition of pathogen molecules, development of method for characterisation of biopharmaceuticals, and development of proteins with high affinity for selected molecular objectives.

The second, equally important national centre with international reputation are the **Structural Biology Laboratories under the CEITEC project**, which focus on integration of three-dimensional structural information describing proteins, nucleic acids and their complexes in a functional context with the aim to understand vitally important processes at the cellular level. Structural biology research focuses on establishing a comprehensive large infrastructure with unique technological equipment for NMR spectroscopy and molecular cryo-electron microscopy and tomography (Titan Krios), complemented by laboratories for X-ray diffraction, study of bimolecular interactions and Atomic Force Microscopy. The NMR spectroscopy laboratory under the 7th FP EAST-NMR project provides access to and services for European users and will also participate in the Bio-NMR project prepared in close synergy with the INSTRUCT project in order to make the unique apparatuses in the NMR laboratories available.
Staff in both of the emerging centres is already closely connected to the ESFRI 7th FP INSTRUCT project, although they were only accepted to the project consortium as associated members. They possess scientific and methodological excellence, which will be complemented by technical excellence through the implementation of the CEITEC and BIOCEV projects, and they also participate very actively in training students.

CZ-EU OPENSCREEN

CZ-EU OPENSCREEN is an infrastructure for an open-access platform in chemical biology, which already exists and will be further developed within the Centre for Chemical Genetics and the Institute of Molecular Genetics, Academy of Sciences of the Czech Republic in Prague. The centre is already involved in the preparatory phase of the ESFRI project, and the IMG, Academy of Sciences of the Czech Republic, v.v.i. is a partner and the leader of the working package (WP10 – Biology Resources) of the preparatory phase of a project (PP 7th FP) for establishing the EU-OPENSCREEN consortium. Contrary to commercial platforms, EU-OPENSCREEN will focus on non-validated molecular targets, signal paths and neglected diseases. The main activities of CZ-OPENSCREEN include identification of new molecular probes/instruments for basic research and new potential medicines for serious human diseases. The activities of the Czech infrastructure will stem from the activities of the central testing unit (high-throughput screening – HTS) with open access for users from the CR and abroad. The infrastructure is intended for those researchers from universities and research institutes who have limited or no access to an infrastructure of this kind. The infrastructure will cooperate with leading institutions in the CR and emerging centres (such as BIOCEV, CEITEC and BioMedReg) and other ESFRI infrastructures (EuroBioimaging, Infrafrontier, INSTRUCT). The infrastructure will offer a broad portfolio of services from test development and high-throughput screening (HTS) to the subsequent validation of results on various in vitro and in vivo models. The infrastructure will further include the National Collection of Compounds connected to the European collection and database of compounds (ECBD) and will contain a screening library under EU-OPENSCREEN, thus providing open access to this unique collection of compounds also to experts from the CR. The associated Central Database of Screening Results, Detailed Protocols and Information on Chemical Compounds will be made available to the public once the specified protective period has expired. The project has applied for financing from the OPPC.

Centre for System Biology

The foundations for a large infrastructure – the Centre for System Biology in Nové Hrady were established by the Institute of System Biology and Ecology, AS CR, v.v.i. The infrastructure will have two main areas of focus. Firstly, it will be focus on combination of protein chemistry with molecular system chemistry. The second focus will involve structural biology from the perspective of system biology. The potential of both types of approach in the application sector can be defined as the ***effects of molecular biology on molecular medicine***. This system biology centre primarily plans to provide selected European infrastructures within the ESFRI-SBE consortium, as well as users from the Czech Republic with expertise in model organisms (such as photosynthetic organisms), development of technologies associated with these models and with ecology, standardisation of methodologies and integration of generated data with software and hardware development. In addition, the centre plans to provide educational activities for the new generation of system biologists.

International Clinical Research Centre in Brno

The **ICRC** (INTERNATIONAL CLINICAL RESEARCH CENTER Brno) is a mainly a plan of staff of the St. Ann's Faculty Hospital in Brno in cooperation with experts from Mayo Clinic (a prestigious clinic in the USA). The CzechInvest agency and the Office of the Deputy Prime Minister of the CR for Economy became involved in the planning process in 2005. Project preparation is coordinated under the management of the Masaryk University, Veterinary and Pharmaceutical University, Institute of Scientific Instruments, AS CR in Brno. The ICRC has four main pillars: scientific and research resources, a public medical facility providing clinical and therapeutically preventative care in **cardiovascular and neurological disciplines**, a technological park and an educational centre.

Cardiovascular, transplantation and neurological programmes will be the main areas of focus in research and development. Additional research fields to be supported within the large infrastructure of the ICRC include in particular internal medicine, acute medicine and onco-surgery. Research will focus primarily on the development of new methods and procedures allowing prevention of diseases, early diagnosis of diseases facilitating timely commencement of treatment, individual treatment in view of the specifics of each patient, non-invasive or minimally invasive treatment of diseases to minimise the impact on the patient and the load for the medical staff. The ICRC in cooperation with local partners aims to create a project cluster for highly demanding scientific projects from the basic research phase to preclinical and clinical research. The ICRC could become the bridging project between European and American research. Experts from the ICRC participate in the work of the Czech Alzheimer Society created for joint programming of the topic of neurodegenerative diseases with a special emphasis on Alzheimer disease. If the finance required for this major project is obtained from the OP RDI, the MEYS will commence their access negotiations with the ICRC for the consortium under the pan-European project ECRIN within the ESFRI Roadmap.

Table

Name of large infrastructure	Brief description	Type of infrastructure	Year of completion
Bank of Clinical Samples/BBMRI	Bank of clinical samples of tumours	National part of the ESFRI, national	Existing
BIOMEDREG	Translational medicine	National, potential for connecting to the EATRIS	2014

6 Informatics /e-Infrastructure

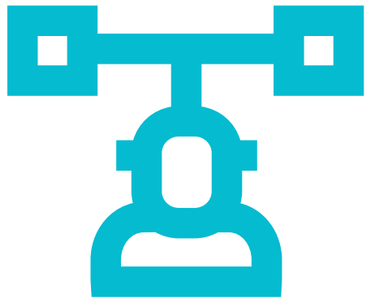
6.1 Current Status

Top-quality and sufficiently dimensioned information technologies are essential for modern science. No scientific team can operate without a solid IT facility but at the same time these facilities share many properties regardless of the particular scientific discipline they serve. IT therefore forms the basic infrastructure – the e-infrastructure, whose development and operation deserves special attention.

The key element of all large e-infrastructures is naturally a stable high-speed communication network providing standard services, such as transfer of large volumes of scientific data, options for creating "private" high-capacity data circuits for interconnecting large scientific infrastructures, but also additional services such as videoconferencing and authentication infrastructures. Transfer of information as such is no longer sufficient and interest in a new level of services typically related to the storage, "smart" distribution and processing of data grows. An e-infrastructure is an environment that offers such comprehensive portfolio of services. As the role of computer simulations and "in silico" experiments becomes increasingly important, an offer of new services in providing and coordination of computing tasks and storage capacities becomes vital. e-infrastructures thus evolve to include supercomputer centres providing cutting-edge computing performance, as well as computing and storage grids whose main task is to interconnect the capacities installed in individual research organisations in a single compact unit, leading to the creation of a completely new standard of a distributed large infrastructure.

The scope of a comprehensive large infrastructure and its services and its distributed character prevent the creation of these types of infrastructures centrally or within a single organisation. The character of and requirements for these large infrastructures are determined by the infrastructural character of projects – i.e. it is a service provided to the entire scientific community rather than to a single or a few particular areas. However, the dominant "supporting" (infrastructural) character must be integrally complemented by the actual research and development activities. These activities may appear as minor in terms of the budgetary requirements but they ensure the cutting-edge parameters of the services provided and the properties that cannot be (yet) obtained commercially or whose commercial price would be excessively high.

Only one large infrastructure - **CESNET** currently operates in the Czech Republic. It is a first-class large communication network for research infrastructure (national research and education network CESNET2), which successfully implements also certain advanced services, such as federalised authentication system, videoconferencing infrastructure, computing and data services, etc. However, these services are predominantly in pilot operation as they continue to be developed. The actual transmission infrastructure meets the current requirements for data transmission efficiency, although the transmission capacity of lines and network nodes will need to be increased for the purposes of advanced applications, which will soon be employed. CESNET forms a part of the pan-European project GÉANT.



6.2 SWOT Analysis

Strengths

- There is a significant potential for utilisation of an e-infrastructure for increasing the effectiveness and competitiveness of research teams (sharing information, knowledge, unique equipment and results of experiments, increasing the effectiveness of communication);
- The essential element (the communication part) of the e-infrastructure in the CR is of a world-class standard – 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 but the capacity is limited – provided by the CESNET association;
- The network and grid parts have long been fully integrated in European infrastructure projects (GN3, EGEE III).

Weaknesses

- Comprehensive e-infrastructures as they are described in strategic ESFRI and e-IRG documents have not been defined in the CR and receive no coordinated support (financial or conceptual). Education in scientific computing is lacking;
- Insufficient computing and storage capacity for the research community; supercomputer resources are non-existent in the CR, although the development of all scientific disciplines and the high level of innovation in the industry require modelling and computer experiments, as well as long-term storage of extensive data files;
- The knowledge of operation and administration of distributed and supercomputer systems and large data storage facilities is distributed unevenly throughout the CR; no clearly defined programmes for training specialists necessary for truly innovative utilisation of the resources of comprehensive e-infrastructures are in place.

Opportunities

- Implementation of the recommended projects in the CR will lead to establishing a comprehensive e-infrastructure for the research and academic community. An infrastructure providing all basic services (network, data storage, distributed computing capacities, supercomputer centres a) is not yet available in the CR and surveys carried out in connection with 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 synergic effect (new levels of cooperation, improved utilisation of capacities, wider range…).
- Implementation of these recommendations will result in simultaneous support of first-class scientific teams and installation of major parts of the distributed e-infrastructure in regions.
- Establishing a high-quality e-infrastructure can contribute significantly to stabilisation of researchers in all scientific disciplines and create good conditions for further personnel growth in the Czech scientific community.
- In the case of distributed computing capacities, a high level of autonomy is retained (most of the equipment will be owned and administered by individual organisations), while the central coordination and interconnection in the grid will facilitate inter-institutional and interdisciplinary cooperation at the national and international level.
- Centrally established supercomputer centres (which have the character of "centres") will also be appropriately integrated in the national system, although with a specific role.

Threats

- Insufficient financing for an e-infrastructure due to underestimation of the requirements for adequate computing and storage capacity for the Czech academic and industrial research;
- Uncoordinated acquisition and especially operation of information technologies (transmission, storage and computing capacities) without a connection to the concept of the national e-infrastructure leading to suboptimal utilisation, undesirable duplication and finally a lack of available performance in locations where it is required;
- The grid part of the e-infrastructure is based on interconnection of computing and storage capacities of individual

entities (RDI projects, ESFRI, universities and research institutions) and its scope and volume of available resources depends on the willingness of these institutions to share their resources;
- An established e-infrastructure may become unsustainable due to a lack of finance for its operation;
- Loss of accumulated know-how and the established international position due to insufficient support for the national part of international e-infrastructures (GN3, EGI, PRACE).

Proposed solution

- A comprehensive large e-infrastructure has the following basic parts:
- Network infrastructure and its services
- Computing infrastructure and its services
- Storage infrastructure and its services
- Horizontal services

MEYS commissioned a topical group to draft a concept for development of an e-infrastructure in the CR in June 2009. The following paragraphs contain the outcome of this work.

Network infrastructure and its services

The actual physical infrastructure implemented by a sophisticated optic transmission system and technologies for data transmission using an IP protocol is the foundation of the network part. The optic infrastructure offers a range of opportunities for operative adjustment of the topology and configuration of transmission channels depending on the current needs (advanced DWDM technology), providing end-to-end high-capacity transmission circuits, etc. The IP layer of the network provides transport services of first-class parameters and a range of additional functions, such as providing virtual private data circuits, optimisation of transmission of large volumes of data in real time, multipoint data distribution, etc. This naturally includes connection to the Internet and a high-speed connection to the European GÉANT network, which essentially means an opportunity for high-quality interconnection between the national and European (and worldwide) research infrastructures.

Computing infrastructure and its services

This part includes especially supercomputer centres and generally centres providing computing capacities to other entities (individuals and organisations). Interconnection of these centres and creation of a layer minimising users' overhead costs arising from the use of multiple centres (from independent use to the option of synchronous work) is essential.

The interconnection of computing capacities of smaller centres is referred to as grid. The grid environment in conjunction with supercomputer centres should form the key elements of the computer infrastructure in the Czech Republic. Unlike supercomputer centres financed from a central source (which are typically placed in a single location), the grid is a distributed environment. Therefore, financing of individual nodes within the grid is primarily the responsibility of organisations operating these nodes. Only coordination is carried out (and financed) centrally as this is essential for ensuring the interoperability in such a heterogeneous environment.

Coordination of acquisition of and providing access to software may be included – individual licences do not need to be purchased under a distributed shared environment – funds can be pooled and full licences available to authorised interested parties can be purchased. Resource pooling also allows the purchase of floating licences, which can be activated "near" data, etc.

Administration of access is naturally included (distributed administration in a distributed environment, i.e. each of the centres controls who will have access to their capacities using uniform instruments, which reduce overhead costs for centres and users alike).

Naturally, the computing part of an e-infrastructure needs to be connected with similar systems abroad to ensure international cooperation between scientific teams. In the case of supercomputer centres, this is addressed in the PRACE project and coordination of grid systems at the European level is addressed in the EGI project.

Storage infrastructure and its services

Users of a computing infrastructure process or generate data – therefore they need an environment for storing input data, interim results and results of calculations.

Long-term storage is another element of the storage infrastructure – this may be provided as a service for third parties (including long-term archiving and guarantee of no loss of data) and as an internal service allowing integration of own data storage with the computing infrastructure.

Optimisation of the network connection among large storage capacities and between these capacities and computing capacities, minimisation of the risk of concentration (all data does not need to be stored in the same place, therefore excessively large data and computing centres do not need to be constructed), optimisation of accessibility (in particular in the case of data with a very high potential number of interested parties), etc. are among the essential requirements.

Data administration including issues surrounding suitable organisation of data (databases) and the so-called trusteeship, i.e. decisions regarding which data should be retained and which can be deleted, represents a special area (where interest is expected to grow in future).

Horizontal services

This area involves in particular a major part of issues associated with security, such as monitoring and response to security incidents, access control (authentication and authorisation), etc. The need for these services is shared by all other parts of the e-infrastructure.

An environment for cooperation (videoconferences, IP telephony, etc.) is also important and the network component and integration with the computing and storage environments, i.e. sharing calculations, data and information, are especially important in this context. Therefore, this service influences all areas listed above and has a character of a horizontal service.

6.3 High-priority Projects

Large infrastructure CESNET – national partner GÉANT and EGI.eu

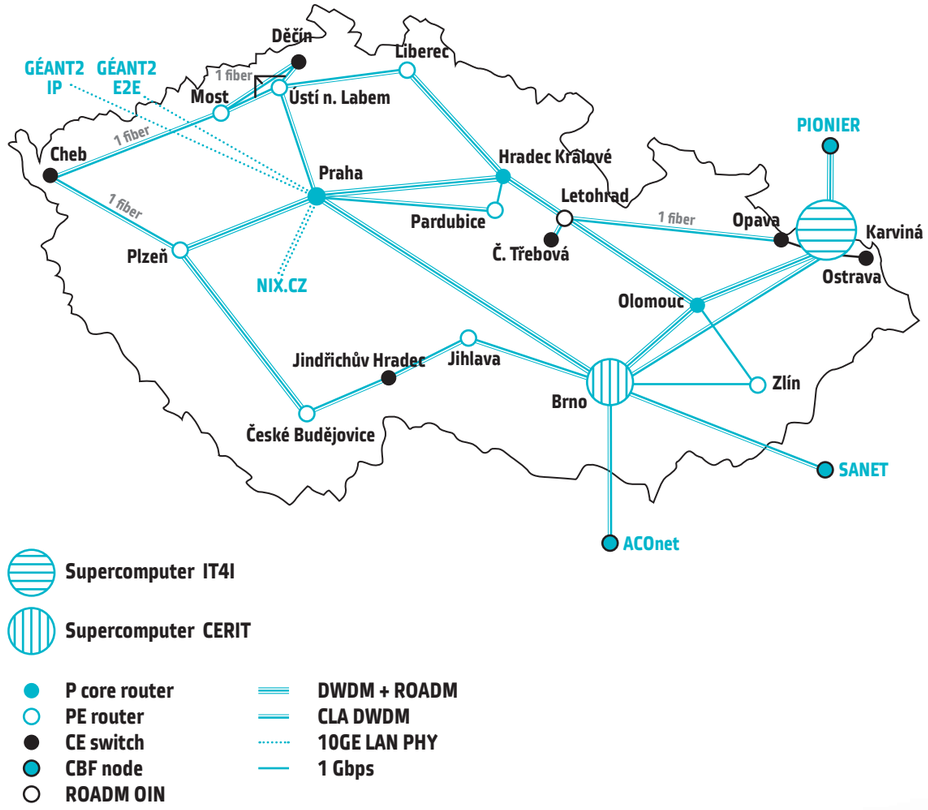
The aim of the project "Large infrastructure CESNET" is to establish a comprehensive large e-infrastructure for research, experimental development and innovations. The infrastructure will include all general components of an e-infrastructure necessary for participation of the CR in the European Research Area and allowing connection to other e-infrastructures described in the ESFRI Roadmap. The main components included in this infrastructure will be as follows: a national communication infrastructure with data transmission efficiency and a national grid infrastructure (NGI) with added instruments and services for controlling access to e-infrastructure resources, instruments for ensuring security of communication and data protection, and instruments for effective cooperation between distributed users and teams. With regard to the communication infrastructure, the project aims to ensure adequate transmission band for the continuously increasing volumes of transmitted data, in particular in view of the expected emergence or research centres such as IT4I, CERIT, BIOCEV, CEITEC and participation of our scientists in international research infrastructures. Connection to similar international infrastructures will be ensured mainly through the GÉANT network. The role of the NGI lies in providing basic computing and storage grid services, integration of significant computing and storage capacities of other entities in these grids and coordination of sharing and utilisation of these capacities. The cooperation with European grid infrastructures will be ensured by the emerging organisation EGI.eu and participation in the EGI project.

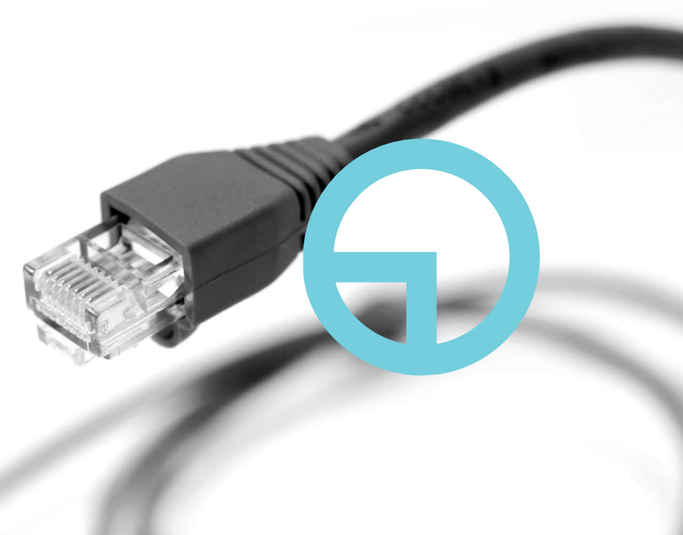
The created e-infrastructure will serve not only as a joint transparent communication environment for cooperation of entities active in research, experimental development and innovation across all sectors in the CR, but also as a testing and development environment for new technologies and applications in information and communication technologies.

Table

Name of large infrastructure	Brief description	Infrastructure type	Year of completion
CESNET	Communication e-infrastructure and the National Grid Infrastructure	National part of the European (GÉANT, EGI)	Existing, Restoration 2015

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





6.4 Promising Projects

IT4Innovations (IT4I) – national partner of the PRACE project

The global objective of the IT4Innovations (IT4I) project is to establish a national centre for excellent research in information technologies in the Czech Republic. The project will involve creation of a research environment, including an adequate infrastructure, focused mainly on research and development of computing methods jointly referred to as High Performance Computing (HPC), with a special emphasis on their usability in applied sciences and development of the information society. Therefore, the aim of the project is to use a highly effective computer infrastructure at the level of TOP 100 most powerful supercomputers to create a broad portfolio of services ranging from research and development of new methods, software support for parallel algorithms, and design and implementation of highly demanding tasks of a multidisciplinary character to providing computing capacities.

It is assumed that in addition to making the HPC services available to national research programmes, the IT4I centre will also be included in European structures for highly demanding computation, which is currently given by its membership in PRACE (Partnership for Advanced Computing in Europe).

CERIT-SC

The CERIT-SC supercomputer centre will be a highly performing centre included in the wider CERIT project and in conjunction with the supercomputer centre IT4I will form the National Supercomputer Centre of the CR integrated in the EU project PRACE. CERIT-SC will be equipped with a highly performing supercomputer (of a standard between TOP 100 and TOP 200), which will be complemented by a system of highly effective clusters, whose performance will be offered through a grid and a cloud interface with a high level of adjustment to users and their immediate needs – interconnection of the two systems will be one of the main development focuses on the centre. 10PB rate storage capacities will allow users medium and long-term storage of extensive sets of data. CERIT-SC has prearranged cooperation and utilisation of the constructed capacities with large newly planned centres of excellence such as CzechGlobe, CEITEC, BIOCEV, RECAMO, ADMAS and through these centres also with significant ESFRI projects in which the CR participates.

Annex

part C

1. List of Abbreviations

A

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

ATLAS – A Toroidal LHC ApparatuS
A detector for the LHC accelerator weighing 7 000 tons and placed 100 metres below ground. It is a multifunctional detector capable of detecting for example Higgs' bosons. The length of the equipment is 44 metre, 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 area)

B

BBMRI – European Biobanking and Biomolecular Resources Research Infrastructures

BHCL – Bibliography of the History of Czech Lands

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

BIOMEDREG – Biomedicine for Regional Development and Human Resources
The project used biomedical disciplines to focus on research and development in biotechnologies and advanced materials and technologies.

BMS – BioMedical Sciences

C

CANAM – Centre of Accelerators and Nuclear Analytical Methods
The Institute of Nuclear Physics, Academy of Sciences of the Czech Republic, v.v.i., is the leading operator of particle accelerators and equipment for analysis using nuclear methods in the CR.

CCP – Czech Centre for Phenogenomics
The centre will focus on the creation and analysis of animal models and the obtained results will be subsequently used to understand the principle of development of diseases in humans.

CEITEC – Central European Institute of Technology
The aim of this project is to increase the regional and national competitiveness by creating a sustainable "engine" generating the region's innovative capacity in biosciences, biomedicine and advanced materials and technologies.

CERGE-EI – Centre for Economic Research and Graduate Education - Economics Institute
This trust was established with the aim to obtain finance for support of economic education in the Czech Republic and the entire Central and Eastern Europe. As the name suggests, the trust CERGE-EI is closely associated with the Centre for Economic Research and Postgraduate Education of the CU in Prague and the Institute of National Economy, Academy of Sciences of the Czech Republic.

CERN - Conseil Européen pour la recherche nucléaire (European Organisation for Nuclear Research)
The most extensive research centre for particle physics worldwide.

CESNET – Czech Education and Scientific NETwork

CESSDA – Council of European Social Science Data Archives

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

CzechCOS – Czech Carbon Observation System
The national centre for studying the impact of global climate change complementing ESFRI infrastructures such as ICOS, EUFAR and LIFEWATCH. A large infrastructure providing facilitates for observation research at the level of individual types of ecosystems and biodiversities in the CR.

D

DWDMD – Dense Wavelength Division Multiplexing
Amplifiers, which need to be present in the signal path due to loss and gradual "weakening" of the signal.

E

ECBD – European Collection and Database of Compounds

EGEE – Enabling Grids for E-sciencE
A functional pan-European large grid infrastructure allowing the wider European scientific community to make use of computing resources, which is currently unsurpassed at the European level.

EGI – The European Grid Initiative (EGI) Design Study – Grid infrastructure
This initiative represents the efforts 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 supporting scientific research in the European Research Area (ERA). National Grid Initiatives (NGIs) ensuring the operation of grid infrastructures in individual countries are the basic building block of 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, identify processes and mechanisms required for establishing the EGI, define the structure of eligible institutions and initiate the establishment of the EGI organisation. The EGI Design Study project is financed from the 7th framework programme of the EU.

(e-IRG) Infrastructure Reflection Group – The main objective is to support the creation of political, technological and administrative framework for easy and economical shared utilisation of electronic resources throughout Europe. Special attention is paid to grid calculation, data storage and networks.

ELETTRA – The synchrotron in Trieste is a major international multidisciplinary laboratory using synchrotron radiation in basic and applied research.

ELI – Extreme Light Infrastructure – project for the most powerful laser worldwide

EMBL – European Molecular Beam Laboratory – a laboratory situated near the ILL and ESRF allowing the preparation and characterisation of samples of biological materials intended for microscopic examination on equipment of the ILL and ESRF.

ENVI – Environmental sciences

EPOS – European Plate Observing System, infrastructure for solid earth science in Europe.

ERIC – European Research Infrastructure Consortium
A new legal framework. Any state that wishes to have an ERIC research infrastructure placed within its territory is required to state in its application that this infrastructure will be deemed an international organisation from the time of its establishment. This makes the consortium exempt from VAT and consumer tax.

ESA – European Space Agency
Currently the second largest space agency worldwide

ESFRI – European Roadmap for Research Infrastructures (European strategic forum for research infrastructures)

ESO – European Organisation for Astronomical Research in the Southern Hemisphere (European Southern observatory)

ESRF – European Synchrotron Radiation Facility. A pan-European infrastructure for multidisciplinary research of advanced materials.

ESRF upgrade – ESFRI project focused on the update of major ESRF facilities.

ESS – European Social Survey
A program focusing on continuous collection of data on basic indicators necessary for explanation of interactions between institutions in the changing Europe.

ESSS – European Spallation Source Scandinavia
A pan-European facility for multidisciplinary research of advanced materials using neutron beams.

EU – OPENSCREEN – The European Infrastructure of Open Screening Platforms
An initiative integrating high performing screening platforms, chemical libraries, chemical resources for major inventions, bio and chemical information support, and databases containing results of screening, test result reports and chemical information.

EUFAR – European Facility For Airborne Research
An initiative supported by the European Commission. The main objective of this project is to integrate methods, technology and experts in aviation research and use this integration for remote sensing in environmental sciences and other sciences studying the Earth.

EUMODIC – The European Mouse Disease Clinic
The main task of EUMODIC will be primary evaluation of the phenotype of up to 650 mice. Lines displaying interesting phenotypes will be subject to further studies.

EUMORPHIA – European Union Mouse Research for Public Health and Industrial Applications
A large project involving cooperation of 18 research centres from 8 European countries. The project was implemented between 2002 and 2006 under the 5th Framework Project. The aim of this project was to ensure cooperation among numerous European centres specialising in the study of a mouse genome and understand the mouse genome to the extent facilitating the understanding of human molecular psychology and pathology.

ERA – European Research Area

F

FAIR – Facility for Antiproton and Ion Research

G

GÉANT – Pan-European research network providing a high-performance infrastructure for high-speed IP connection among universities across Europe.

GN3 – Graphical network simulator
The main characteristic of this project is its focus on the creation and providing advanced information and communication services for end users on a hybrid network infrastructure in a multi-domain environment.

GZK – Greisen-Zatsepin-Kuzmin
The theoretical upper limit of cosmic radiation energies. Kenneth Greisen, Vadim Kuzmin and Georgiy Zatsepin calculated this limit independently of each other in 1966; the limit is based on the mutual influences anticipated between the cosmic ray and photons of the space microwave radiation in the background.

H

HiPER – European **Hi**gh **P**ower laser **E**nergy **R**esearch facility
The facility focuses on proving the viability of a laser-controlled fusion as a future source of energy.

I

ICNC – Institute of Czech National Corpus

ICOS – Integrated Carbon Observation System (ecosystem monitoring network)

ICRC – International Clinical Research Centre

ICT – Institute of Chemical Technology

IG – Institute of Geophysics, Academy of Sciences of the CR, v.v.i.

ILL – Max von Laue and Paul Langevin Institute
A pan-European institute operating the most intensive stationary source of neutrons worldwide, to which 40 unique measuring facilities using neutron beams in modern experimental research in various fields are connected.

ILL 20/20 – ESFRI project focusing on major upgrade of significant facilities in the ILL.

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

INFRAFRONTIER – 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 opportunities for membership of research and development institutions in international non-governmental organisations focused on research and its support .

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

IP – Institute of Physiology, Academy of Sciences of the Czech Republic, v.v.i.

IPE – Institute of Physics of the Earth is a geo-science facility of the Faculty of Science of the Masaryk University in Brno.

IS AS CR – Institute of Sociology, Academy of Sciences of the Czech Republic

J

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

L

LIFEWATCH – An e-infrastructure focusing on all aspects of research of protection, management and measurement of changes in biodiversity.

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

LSM/JOULE – Laboratoire Souterrain de Modane/JOint Underground Laboratory in Europe
This project with a seat in France covers a major part of contemporary physics carried out in underground laboratories.

LNSM – Laboratory for Nanostructures and Nanomaterials
This laboratory is an essential facility for the experimental study of a whole range of quantum relativistic phenomena in solid substance physics and for the study of the properties of microelectronic components with dimensions smaller than 100 nanometers.

M

MLTL – Magnetism and low temperature laboratories operated by the FMP CU in cooperation with the Institute of Physics, AS CR – they offer a wide scientific community 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
An American governmental agency responsible for the American space programme and general research in aviation.

NIF – Nadační investiční fond (Investment trust)

NMI3 – Integrated Infrastructure Initiative for Neutron Scattering and Muon Spectroscopy

NUTS II – Nomenclature des Unites Territoriales Statistique (Nomenclature of Territorial Statistical Units)
Territorial units (II – at the regional level) created for statistical purposes

O

OP RDI – The Research and Development for Innovation Operational Programme

ORFEUS – European seismologic centre in Holland

P

PALS – Prague Asterix laser System
A research centre established as a joint facility of the Institute of Physics, Academy of Sciences of the Czech Republic and the Institute of Plasma Physics, Academy of Sciences of the Czech Republic designed as a user laboratory providing facilities for experimental research in high-performance lasers and physics of a laser generated plasma. The centre was opened to external users in September 2000.

Pierre Auger Observatory – This laboratory focuses on the study of the spectrum and composition of the highest energy cosmic radiation. The Pierre Auger Observatory was constructed under international collaboration in the Mendoza province in Argentina.

PRACE – The Partnership for Advanced Computing in Europe
A network of supercomputer centres in Europe aimed at increasing the use of mathematical modelling in the solution of highly demanding research and practical tasks in the industry. The PRACE project was launched under the 7th Framework Programme of the European Union.

R

ReCAMO – Regional centre of applied molecular oncology

RECETOX – Research Centre for Environmental Chemistry and Ecotoxicology – it is a separate institute of the Faculty of Science of the Masaryk University, which carries out research, development, tuition and expert activities in environmental pollution with toxic substances. The institute's special areas of interest include persistent organic pollutants (POPs), polar organic substances, toxic metals and their species and natural toxins (cyanotoxins)

RS – Remote Sensing
The facility organisationally falling under crystallinics specialises in comprehensive interpretation of satellite and aerial images, and all available geo-information products.

S

SDA – Sociological Data Archive

SHARE – Survey of Health, Ageing and Retirement in Europe
This project focuses on generating a publicly accessible international comparative database on the condition of the generation over 50 years of age and the entire society across Europe.

SSH – Social sciences and humanities

SIAEOS – Svalbard Integrated Arctic Observing System

SPIRAL2
A facility producing radioactive beams using the isotope separation method

T

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

ThALES – Three Axis Low Energy Spectrometer
The project (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
An international infrastructure focusing on the generation of intensive X-ray radiation and its utilisation in modern material research

7

7th FP – 7th Framework Programme

2. Overview of the Composition of Working Groups

Opponent Group

prof. Ing. Ivan Wilhelm, CSc., e-infrastructures and overall summary – head of the opponent group
prof. MUDr. Milan Macek, ml., DrSc., biomedicine
prof. RNDr. Bedřich Moldan, CSc., environmental sciences
Ing. Stanislav Pospíšil, DrSc., physics and material research, space
prof. Ing. Jaroslav Kadrnožka, CSc., energy
prof. PhDr. Petr Sommer, CSc., social sciences and humanities

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prof. PhDr. Milan Hlavačka, CSc., CU in Prague
doc. Ing. Daniel Münich, PhD., CERGE-EI
doc. RNDr. Karel Oliva, Dr., ICL AS CR

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prof. RNDr. Ing. Michal V. Marek, DrSc., ISBE AS CR – head of the thematic section
doc. RNDr. Jan Kirschner, CSc., IB AS CR
Ing. Jiří Hladík, PhD., VÚMOP, v.v.i.
doc. Ing. Marek Turčáni, PhD., ČZU in Prague

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RNDr. Josef Krása, CSc., IP AS CR
prof. RNDr. Vladimír Sechovský, DrSc., CU in Prague
prof. RNDr. Pavel Lejček, DrSc., IP AS CR
doc. Ing. Vladimír Hnatowicz, DrSc., INP AS CR
prof. RNDr. Jan Palouš, DrSc., IA AS CR
doc. Ing. Jan Kolář, CSc., Czech Space Office
prof. Dr. Ing. Jaroslav Sojka, VŠB-TU in Ostrava

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Ing. Jiří Sitera, UWB in Plzeň

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Ing. Jan Dohnálek, PhD., IMC AS CR
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doc. MUDr. Dalibor Valík, Ph.D., MIO Brno
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doc. RNDr. Rüdiger Ettrich, PhD., ISBE AS CR

Coordinating Group

Ing. Naděžda Witzanyová, MEYS, representative of the Czech Republic in the ESFRI, member of the ESFRI Executive Board
RNDr. Jan Hrušák, CSc., AS CR, representative of the Czech Republic in the ESFRI
Bc. Gabriela Vlčková, MEYS
Ing. Jakub Johaník, MEYS

Table of Projects

Name of large infrastructure	Infrastructure type	Priorities Research	Note
SOCIAL SCIENCES AND HUMANITIES (SSH)			
Bibliography of the History of Czech Lands (BHCL)	National	8	Existing
CESSDA	Major Czech node under the ESFRI	6, 8	Restoration - 2014
ESS – survey	Major Czech node under the ESFRI	6, 8	Restoration - 2016
LINDAT/CLARIN	Major Czech node under the ESFRI	6, 8	2013
SHARE	Major Czech node under the ESFRI	6, 8	2020
Institute of the Czech National Corpus	National	6, 8	Existing
ENVIRONMENTAL SCIENCES (ENVI)			
CzechCOS/ICOS	Major Czech node under the ESFRI	1, 2, 3	2015
EUFAR	ESFRI	1	2015
LIFEWATCH	ESFRI	1, 6	2015
CzechPolar	National	1	Existing
CzechGeo/EPOS	Major Czech node under the ESFRI	1	Restoration - 2015
ENERGY			
ITER	International	3	Prep. phase
HiPER	ESFRI	3	Prep. phase, 2018
JHR	ESFRI	3	Prep. phase, 2014
COMPASS-D	National, partner to ITER	3	Existing
Reactors in Řež	National	3	Existing
CVEVL	National	3	Prep. phase
Sustainable Energy (4th gen. reactor)	National	3, 8	Prep. phase
BIOMEDICINE			
INFRAFRONTIER	Major Czech node under the ESFRI	2	New proposal
EuroBioImaging	Major Czech node under the ESFRI	2, 6	New proposal
INSTRUCT	Associated partner of ESFRI	2	New proposal
Centre for System Biology	National	1, 2	New proposal
BIOMEDREG	National	8	New proposal
Bank of Clinical Samples/BBMRI	National, associated partner of ESFRI	8	Existing/involvement in ESFRI
ICRC	National	8	New proposal

Name of large infrastructure	Infrastructure type	Priorities Research	Note
MATERIALS PHYSICS AND SPACE			
PALS	National	3, 4	Existing
MLTL	National	4	Existing
NPI accelerators + LNF	National	4	Existing
LNSM	National	4	Existing
Van de Graaff	National	4	Existing
SAFMAT	National	4	New proposal
Wind tunnels	National	5	Existing
CERN	International org.	3, 4, 5, 6	Existing
Tevatron Fermilab	International org.	4	Existing
Pierre Auger Observatory	International org.	4	Existing
LSM/JOULE	International org.	4	Existing
ESRF & ESRF upgrade	ESFRI, international org.	4	Restoration - 2018
ILL & ILL 20/20	ESFRI, international org.	4	Restoration - 2012
ThALES – ILL upgrade	ESFRI, international org.	4	New proposal
ELETTRA (Czech Beamline)	International org.	4	Existing
ESO & Centrum pro ESO-ESA-NASA	International org.	4	Existing
ELI	ESFRI	3, 4	New proposal
ESS – Scandinavia	ESFRI	1, 4	New proposal
XFEL	ESFRI	4	New proposal
INFORMATICS/e-INFRASTRUCTURE			
CESNET	Czech part of Géant, EGI	6, 8	Restoration - 2015
IT4Innovations	Czech partner of ESFRI	6	New proposal
CERIT	Czech part of EGI	6	New proposal

The table includes a list of projects included in the Czech Roadmap of Large Research, Development and Innovation Infrastructures. Large infrastructures are divided according to their relevant priorities of applied research - 1. Biological and ecological aspects of sustainable development, 2. Molecular biology and biotechnology, 3. Energy sources, 4. Material research, 5. Competitive engineering, 6. Information society, 7. Safety and protection, 8. Priorities of development of the Czech society.

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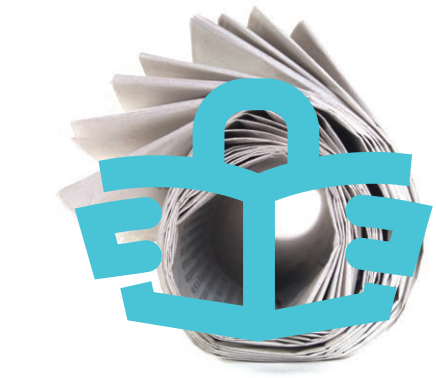

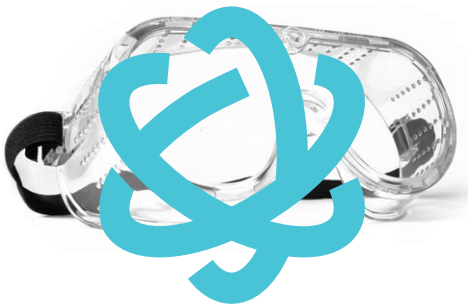


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