National Research, Development and Innovation Office

Hungary

National Research Infrastructure Roadmap

2018

Contents

Background

Europe's future prosperity largely depends on how Europe can take advantage of the potential lying in scientific and technological innovation in the present economic situation generally characterised by increased competition, globalisation and the appreciation of knowledge. This requires internationally renowned, high quality educational and research institutions, as well as access to outstanding **research infrastructures (RIs).**

To this end, the **European Strategy Forum on Research Infrastructures (ESFRI)** enlists the research infrastructures significant at European level and necessary for meeting the long-term needs of European research communities in a regularly updated document titled *ESFRI Roadmap*. Parallel to this, most EU member states have prepared their own national research infrastructure roadmaps to map domestic RIs, assess their compatibility with European RIs and provide guidelines for their future development.

Research infrastructures are increasingly indispensable to research communities around the world. The **most advanced RIs** being implemented in Europe are highly expensive equipment, facilities or databanks the establishment and operation of which exceed the economic capacities of a single country, therefore they are implemented in international cooperation (primarily within the EU)[1]. The technological level of these RIs is outstanding and unique even by European or international standards, so they play a decisive role in achieving exceptional scientific results in Europe. For Hungary, the E**xtreme Light Infrastructure Attosecond Light Pulse Source (ELI-ALPS)** facility has particular importance: it is a major contribution to laser research and can open new ways for physics, chemistry, materials science and medical biology. The facility, which started operation gradually in late 2017, is mainly used for basic research but will also contribute to applied research and, as a spillover effect, to industrial application.

In addition to the ELI-ALPS, there are **several other research infrastructures in Hungary.** These lower cost RIs can be financed from national funds and are **normally not considered as unique facilities, still, they are essential for Hungarian researchers.** To use the large scale European RIs and join the international scientific networks around them, Hungary needs well-equipped domestic RIs. One of the main aims of the calls for proposals announced through the National Research, Development and Innovation Office (NRDI Office) since 2015 have been the development of RIs. As a result, advanced equipment has been purchased and installed in many fields of science which significantly contributed to Hungarian researchers' competitiveness even in European comparison[2].

[1] For the definition of RI see Chapter 2.4.

[2] For details on the development and funding of RIs see Chapter 4.

Summary

The National Research Infrastructure Roadmap (hereinafter: *National Roadmap*) aims to provide an insight into the operation of major Hungarian RIs, present the nature and the diversity of the domestic RI capacities, increase the national and international visibility of Hungarian research capacities and opportunities, and provide background information for identifying further development areas for RIs.

The Roadmap is primarily recommended to domestic, European and international researchers, but it can also be used by policy-makers and the wider audience involved or interested in domestic research infrastructures. The Roadmap was preceded by extensive preparatory work covering the entire research sector and is the result of the professional work of the National Research Infrastructure Committee coordinated by the NRDI Office as well as invited academic professionals.

The first part of the document briefly outlines the backgrounds: the *ESFRI Roadmap* and its function, and explains why it is necessary and useful for all countries to prepare their own national roadmaps. When elaborating the *National Roadmap*, due consideration was given to the relevance of RIs to Hungarian researchers.

The general background information is followed by the presentation of the methodology used for creating the roadmap: the definition of the research infrastructures, the process of elaborating the roadmap and the selection criteria applied. The issues relating to RI funding, monitoring, regular supervision and future development directions are also discussed here.

The second part of the document presents the selected 26 research infrastructure groups in the 6 ESFRI thematic areas. Each group covers a larger field of research and comprises all relevant domestic RIs and the research groups operating them. The groups contain both internationally acclaimed, open RIs representing cutting-edge technologies just like RIs with a primary focus on their own, internal research. In each infrastructure group, the document highlights those RIs which have achieved major development in the framework of the large-scale infrastructure development programme in the past 2 years.

The recently launched large-scale RI development programmes have significantly improved the technological level, openness and networking ability of Hungarian RIs. At the same time, the decades-long lack of RI development funds and the efforts to secure the exclusive use of RI capacities still have a noticeable impact on research groups. Most importantly though, there are also clear efforts to integrate domestic RIs and related research groups into the international research community. This, however, needs further endeavours both from the research community and the policy-makers.

1. The preparation of the National Research Infrastructure Roadmap

1.1. The role and function of the *ESFRI Roadmap*

Established in 2002, the **European Strategy Forum on Research Infrastructures (ESFRI)** identifies research infrastructures significant at European level and necessary for meeting the long-term needs of European research communities. It aims to strengthen the coherence and strategic approach of the EU's RI-related policy and to launch initiatives promoting the more efficient use of RIs. Another aim is to make an overview (roadmap) of the current situation of the research infrastructures and future goals covering 10-20 years length of time. **The first roadmap was published in 2006** and was updated several times later on. Presently, the Roadmap 2016 is being updated to create the Roadmap 2018.

Cutting-edge research infrastructures are so extremely resource demanding (in terms of equipment, appliances, ICT, data and human capacities) that no EU member state could operate them alone cost-effectively. The full budget spent on European RIs is around EUR 10 billion a year[3]. The selection and establishment of RIs require a **single strategic approach at European level**, which is coordinated by the ESFRI.

ESFRI RIs operate on the basis of a life-cycle model. Accordingly, there are **ESFRI projects** and **ESFRI landmarks** which represent different stages of the life cycle. ESFRI projects are new initiatives selected on the basis of excellence and maturity in a complex assessment process. The **Roadmap 2016 contains 21 ESFRI projects**, 9 of which were taken over from the 2008 roadmap and 6 from the 2010 roadmap, while 5 new projects were selected and 1 project was revised and modified. ESFRI landmarks are infrastructures already started or soon becoming operational and will have a decisive role in boosting the competitiveness of the European Research Area (ERA). **The 2016 roadmap lists altogether 29 ESFRI landmarks.** Projects which cannot be realized in 10 years are removed from the *Roadmap*. Landscape analyses are further important components in the roadmaps. They provide a comprehensive picture about the open European RIs available for the wider audience as well as about all major new and ongoing projects in all research areas.

1.2 The importance of research infrastructures

The European Commission's report on the consultation on the long-term sustainability of research infrastructures[4] highlights that "ensuring access to world-class research infrastructure facilities is crucial to staying at the forefront of science and technology and remaining competitive in a global knowledge-based economy. *But some science facilities are just too big or complex for a single country to build and manage alone. The European Strategy Forum for Research Infrastructures (ESFRI) was set up in 2002 to help coordinate the development of large-scale research facilities in the European Research Area.*"

To sum up, research infrastructures are important because they:
- provide a basis for scientific discoveries and for expanding our knowledge of the world;
- determine the international scientific competitiveness of a country;
- facilitate the reinforcement and expansion of human research capacities;
- strengthen cooperation and networking between researchers and research groups;
- promote knowledge-sharing between the research community and the business sector;
- provide potential answers to global challenges;
- generate significant socio-economic effects.

[3] Source: *ESFRI Roadmap 2016*

[4] *European Commission, Directorate-General for Research and Innovation:* Report on the Consultation on Long Term Sustainability of Research Infrastructures, May 2016

Scientific discoveries, extension of knowledge

Research infrastructures represent **the nodes of state-of-the-art world-class research** at national, European and global level. They enable researchers to examine various materials, resources and data and draw conclusions in an internationally outstanding, unique technological environment. With RIs researchers can access infrastructures that would not otherwise be available to them, facilitating a creative work that can further extend our knowledge of the world. RIs have contributed to **many major scientific discoveries.** Effectively operating RIs attract outstanding scientists from around the world, further strengthening and expanding the network of research communities. Therefore, one of the main roles of RIs is to **concentrate** research capacities, **expand** research knowledge both in terms of quality and quantity, and **answer** challenging questions. In order to make domestic research effective and globally successful, it is essential to ensure that Hungary participates in international and EU research infrastructures.

RI quality determines the level of international scientific competitiveness of the country

he scientific and technological quality of research infrastructures available in a country and the embeddedness of domestic research communities into European and international scientific life largely determine the country's international scientific competitiveness. Accordingly, the European Union also considers the development of research infrastructures a strategic priority. Increased and globalisation fundamentally affects society, business operation and business models, as well as research capacities. The external changes triggered an increasing demand for more open RIs. The appreciation of knowledge, as a dominant trend in the world economy, forecasts the importance of knowledge-sharing both within the research community and between the business sector and the academic world. One of the possible channels of knowledge-sharing might be RIs and the researcher networks around upon them.

The reinforcement of human research capacities

As a further advantage, research infrastructures provide a great opportunity for **domestic researchers for high quality professional development.** They facilitate access to international networks and support multidisciplinary cooperation. They also offer unrivalled opportunities to domestic researchers in different circumstances. Thus, research infrastructures also contribute to the recognition of the research career and improve the social acknowledgement of researchers.

Strengthening cooperation and networking between researchers and research groups

Besides the socio-economic effects, digitisation also fundamentally influences research. Advances in digital technology have made it unpredictably easy to share knowledge and to store and freely access research information. Also, research is becoming increasingly multidisciplinary: many scientific problems require collaboration between scientific fields, which forces researchers to work together and join networks. Adaptation to these changed circumstances and the increased **internationalisation of science are key to maintain and improve the competitiveness of the domestic research community.** European and international RIs play a pivotal role in this.

Sharing knowledge between the research community and the business sector

As another crucial role, RIs try to **bridge the gap between the academia and the industry**. Scientifically sound, economically and socially beneficial innovation can only be achieved through close professional cooperation between the business

sector and the RIs operated at research institutions and universities. RIs can only secure **knowledge-sharing** on solid strategic foundations, that is, through openness, a management approach (having the required personal and organisational conditions) and cost-effectiveness. One of the conditions for the effective operation of RIs is to **find the optimal ratio between discovery research and innovation-driven research**. The former usually delivers results in the long term and is primarily motivated by the desire for discovery, while the latter is mostly aimed at the quick solution of a problem and the commercial exploitation of the results. The classic RIs (see: ESFRI projects, landmarks) have been and are created for basic research purposes. Still, there are research infrastructures where **technological development** is also dominant. The two directions are closely related. No major discoveries can be achieved without basic research, but of course, it is also important that the results of research have wide socio-economic utilization.

Socio-economic effects

The most important research infrastructures **address some of the most pressing global challenges**, such as climate change mitigation, efficient energy use, environmentally friendly and sustainable agricultural technologies, and aging society. These global problems also affect Hungary, so the search for solutions both challenge domestic researchers and businesses and provide opportunities to them. In fact, these problems form part of the megatrends that will have a strong impact on science, technology and innovation systems over the next 10-15 years.[5]

However, the **impact of RIs is not limited to the research community**. The establishment and operation of an RI, such as the ELI project in Hungary, have considerable economic effects for the region by boosting local procurement, investments and employment. In addition to the direct economic benefits, the openness of RIs (i.e. access to them under certain conditions) **opens doors to R&D businesses**, enhancing their research infrastructure and strengthening their market position.

An ELI-sized RI **positively affects life in its immediate environment.** It attracts top researchers from around the world who will have higher expectations from the educational, cultural and health services and will also shape social life and community.V

Finally, RIs have a positive effect on education: by cooperating with higher education institutions they can provide valuable experience to students through internships and training programmes and ultimately make research careers more attractive. The training of technical staff working in the industry or in public research institutes also helps to increase the number of available and well-trained professionals with proper innovation and IT skills. RIs can also contribute to the **training and career orientation of students** studying in public education institutions.

[5] Megatrends are large-scale social, economic, political, environmental or technological changes that are slow to form but which, once they have taken root, exercise a profound and lasting influence on many if not most human activities, processes and perceptions. (OECD Science, Technology and Innovation Outlook 2016).

2. The background and methodology of creating the *National Research Infrastructure Roadmap*

2.1. The role and function of the National Research Infrastructure Roadmap

The primary role of the ***National Research Infrastructure Roadmap*** is to give a comprehensive picture of the current situation of major domestic research infrastructure capacities to various target groups, and to serve as a point of reference when setting the future development directions for RIs.

The primary direct target group of the *Roadmap* is the domestic, European and international research community. The *National Roadmap* lists Hungarian research equipment, devices, databanks and laboratories. It presents the internationally acclaimed state-of-the-art domestic research infrastructures and outlines the research communities that are already working together with ESFRI research infrastructures. Importantly though, the document also records research groups that are not yet connected to any EU RI, either because they have not been given the opportunity, or their research area is not closely connected to any RIs that exist or are under construction. The *National Roadmap* also provides a great opportunity for policy-makers and other persons involved in the background support work and management tasks related to the research infrastructures to become aware of the main advantages, strengths and trends of domestic research. In addition, the *National Roadmap* may also be of interest to a wider audience and may therefore increase the visibility and acknowledgement of domestic scientific research.

ESFRI encourages all EU member states to create their own national roadmap on research infrastructures. The elaboration of a roadmap, as a widely used tool in planning and development policy, enables the organisation primarily responsible for the domestic distribution of public RDI funds to

- map currently available research infrastructures in Hungary;
- present the excellence of domestic research communities;
- provide guidance to domestic research communities on professional opportunities and expectations;
- formulate recommendations for domestic R&D areas;
- ensure the professional background for strategic issues and decisions relating to research infrastructures;
- outline the structural and system elements required for the efficient and sound operation of research infrastructures;
- provide an opportunity to inform the broader audience.

2.2. The background of preparing the *National Research Infrastructure Roadmap*

he targets for European research infrastructures is primarily provided by the *ESFRI Roadmap*. The *National Research Infrastructure Roadmap* is a planning document which **fits with the ESFRI targets, the national RDI strategy and the National Smart Specialisation Strategy (S3).** The milestones of creating the Hungarian *National Research Infrastructure Roadmap* are the following:

In December 2008 the *National Research Infrastructure Survey and Roadmap* (NEKIFUT; hereinafter: Register) was launched with the aim of mapping and online publication of the most important characteristics and development needs of the existing domestic research infrastructures. The first pieces of information on research infrastructures of utmost importance for scientific, economic and social development (strategic research infrastructures or SRI) were recorded in a dedicated Register between 2009 and 2010. Research infrastructures were assessed by panels of researchers, lecturers and

economic players in a transparent and public procedure and only those were qualified as SRIs which operated as a network with a single unique development concept.

Three years after the start, it became necessary to update and expand the *Register*, so in February 2014 the database of research infrastructures was updated based on a competitive call for proposals. It was key point that the *Register* should not only include SRIs but also the broadest possible scope of research infrastructures.

2.3. The National Research Infrastructure Committee

The **National Research Infrastructure Committee** (NKIB) was established in 2014. It is a body comprising the representatives of scientific and administrative organisations representing the main fields of science, the university and academic sector, and governmental actors responsible for research infrastructure policies.

The NKIB is responsible for mapping the domestic research infrastructure, planning cooperation with foreign research infrastructures, and monitoring scientific performance resulting from such cooperation. Where it was considered professionally necessary, external stakeholders were also involved in the planning of the Roadmap. The NKIB **expresses views** and **makes proposals** to governmental decision-makers on all issues relating to domestic research infrastructures. It lays the groundwork for governmental decisions on research infrastructures, infrastructural investments in Hungary and the participation in the RI projects specified in the *ESFRI Roadmap.* The NKIB expresses views on signing Memorandums of Understanding (MoU) and other documents in which Hungary assumes commitments, on matters related to the preparation of S3 related decisions and on professional issues connected with the comprehensive national database of research infrastructures.

First, relying on researchers' expert opinions, the NKIB proposed a list of international research infrastructures which Hungary should join and then, in the spring of 2016, started the direct preparations for the national research infrastructure roadmap.

2.4. The definition and types of research infrastructures

In the *National Research Infrastructure Roadmap* 'research infrastructure' is an umbrella term with the following meaning:
the totality of equipment, laboratories, databanks, information systems, related human capacities (including researcher, operative, maintenance and management capacities), expertise and services supporting scientific activity which thematically match or form a single thematic unit and which are necessary for high quality, internationally competitive research work.[6]
Research infrastructures not only take diverse forms (equipment, databank etc.) but also greatly vary by physical location and the number of the relevant scientific fields. **Research infrastructures are used in all fields of science** but in different forms. Some fields have substantially greater demand for capacity than others due to the establishment and operation of large and complex equipment (which goes significantly beyond national capacities).

[6] In line with the definition of research infrastructures provided in Section 2(1)42 of Government Decree 380/2014 (XII. 31.) on the rules of operation and use of the National Research, Development and Innovation Fund, which is based on the interpretation in Article 2(91) of Commission Regulation 651/2014/EU.

2.4.1. General RI types by physical location

By physical location, we distinguish between **single-sited, distributed and virtual** research infrastructures.

- Single-sited RIs operate in a clearly identifiable, single location.
- Distributed RIs operate in multiple, mutually complementary sites (measuring stations, collections, laboratories).
- Virtual RIs comprise electronically available services, networks, archives, databases and databanks. The latter group does not necessarily exclude the other two: many distributed research infrastructures are also virtual ones. For instance, in the case of Euro-BioImaging (an ESFRI research infrastructure) virtual research infrastructure means access to shared databases and software. Other infrastructures with essentially purely virtual elements include SHARE-ERIC and the e-infrastructures.

2.4.2. RI types by geographic location from a Hungarian perspective

Looking at the RIs currently available to Hungarian researchers, **the following types of research infrastructures may be distinguished by geographic location:**

- flarge-scale research infrastructure partly located in Hungary (ELI-ALPS – distributed RI)
- single-sited, distributed and/or virtual research infrastructures not located in Hungary for which Hungarian researchers have access to (e.g. HL-LHC, European XFEL, ELIXIR, Euro-BioImaging, SHARE-ERIC, ESS-ERIC, PRACE);
- smaller RIs located in Hungary in a single site or as a researcher cooperation network offering access to local, national and, as the case may be, foreign researchers (see RI groups and RIs in Chapter 7).

2.4.3. Thematic categorisation of RI types by field of science

Research infrastructures can also be grouped thematically. The ***ESFRI Roadmap 2016*** **sets the following 6 thematic areas:**

- energy;
- environment;
- health and food sciences;
- physical sciences and engineering
- social and cultural innovation;
- e-infrastructures.

The *National Roadmap* classifies domestic RIs according to these 6 areas. This classification caused difficulty in many cases due to the interdisciplinary nature of research themes or to the extensive scope of the ESFRI categories (health and food, physical sciences and engineering).

Background research infrastructures should also be considered in the context of the thematic classification. This category includes national and international **information networks** enabling high speed data transmission and communication and **library services,** in particular, systems ensuring access to international publications. Special background infrastructures include, in particular, **open access to research results**, which is enabled by the increased penetration of internet technology and the evolution of scientific communication. The National Research, Development and Innovation Office is committed

to promote open access in Hungary and thus further the goals of the European Commission. To this end, the President of the NRDI Office initiated the establishment of the Open Science Expert Committee. Furthermore, to propagate open access in Hungary, domestic higher education institutions and the HAS Library and Information Centre created a consortium which aims to increase the national and international visibility of Hungarian science by the effective dissemination of scientific results, namely by building a national infrastructural network for open access repositories, creating a methodological centre, the domestic application of foreign know-how and international standards, adopting the complementary channels of scientific communication and fostering international relationships.

The relevance and the quantity of these **background infrastructures** have substantially increased recently. They belong to the ESFRI category of **e-infrastructures**.

2.4.4. The set of criteria used for creating the *National Research Infrastructure Roadmap*

In order to create the roadmap, a set of criteria was necessary **for the classification of RIs operating in Hungary.** The list of RIs to be included in the *Roadmap* was too large and very heterogeneous. So, their classification were based on and justified according to the following **selection criteria:**

Selection criteria:

- **Open access and capacity** – provides access to any domestic and international research community subject to the availability of capacities; open to industrial cooperation (for a fee); able to provide and operate the services necessary for open use (umber of cooperation agreements).
- **International connection** – maintains and is actively involved in actual international research cooperation; able to host foreign researchers; and able to participate in international research projects (number of international research infrastructure cooperation agreements generated by the research infrastructure).
- **Uniqueness, scientific excellence** – outstanding technology level and associated expertise makes it comparable with the relevant European RIs (number of publications and patents authored together with external researchers, broken down by research institution).
- **National (strategic) importance** – has scientific importance for at least the domestic research community (number of researchers served, including PhD students).
- **Room for further development** – keeps abreast of new development trends; has the potential of adapting and developing further technologies.

2.5. The classification of Hungarian research infrastructures into RI groups

The *National Research Infrastructure Roadmap* **classifies RIs operating in Hungary into research infrastructure groups** which were set up with respect to the following factors:

- Most of the RIs operating in Hungary are not unique and can be found in large numbers in European countries excelling in RDI.
- They provide the essential professional background for a country to be able to integrate into the international research community. Here researchers can acquire the professional skills required for taking part in a large RI considered unique at international or European level.

- IR groups may facilitate cooperation between Hungarian RIs belonging to the same group and improve the professional performance and international involvement of Hungarian research groups.

The individual RI groups were created according to specific research fields and related areas. This means that individual RIs were classified into the same group based on their cooperation, and their possession of relevant infrastructure and research community. Another major factor considered in creating the groups were the support of development directions and priorities specified in the National Smart Specialisation Strategy (S3).

The following criteria were used for the creation of RI groups and the classification of individual RIs:

- The selection should prefer **scientific diversity**.
- The selection of RIs **should not compare the performance and output of main scientific areas**, such as life sciences and social sciences, as they are inherently significantly different.
- The selection should take into consideration **sustainability.**
- The presentation should not be limited to RIs already having ESFRI or other international memberships, but the selection should cover the **entire spectrum** of domestic research infrastructures.
- The selection should be performed on **professional** grounds, by the representatives of scientific community.

The RI groups presented in the *Roadmap* were **selected** and the individual RIs were **grouped** with the help of the research community as follows:

1. The creation of **the list of domestic research infrastructures (103 strategic and 280 registered RIs)** was preceded by a multi-stage preparatory work which represented the starting point for the selection of the research infrastructure groups.
2. Since 2015 **several major funding programmes** have been announced for the research community and for the development of research infrastructures. The research infrastructures to be implemented/developed in the framework of the programmes were also taken into account during the mapping of the RIs.
3. A system of assessment criteria was developed for the selection process and was approved by the NKIB.
4. **Within the scientific fields, the research infrastructure groups** were selected based on the domestic characteristics.
5. Each domestic **RI was classified into one of the RI groups**.
6. In every group one RI was selected as the **coordinator institution** and the rest as partner institutions. A number of the RIs funded in the latest research infrastructure development programme were selected in each group and presented as examples in the *Roadmap*.

The methodology used for elaborating the *National Research Infrastructure Roadmap* is shown in Figure 1.

Note that parallel to creating the *Roadmap*, Hungary also updates its RDI strategy. The *Roadmap* results are going to be used for the renewal of the RDI strategy and action plan as it is one of the background documents for renewing the RI-related objectives of the RDI strategy.

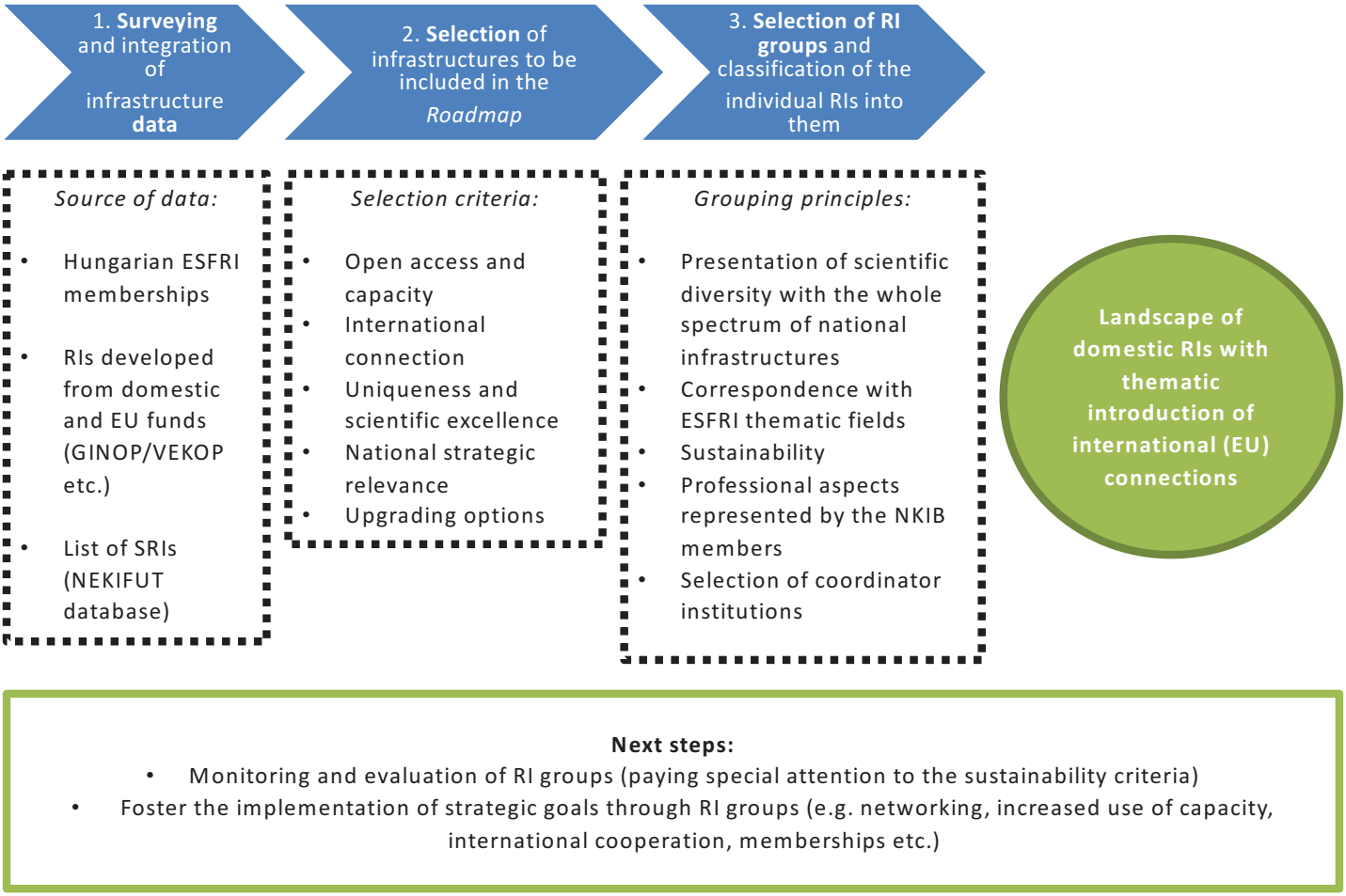


Figure 1: The methodology used for creating the *National Research Infrastructure Roadmap*

3. Hungary's participation in European research infrastructures

Hungary has long-established and internationally recognised traditions in the field of research and development, which is also demonstrated by the country's scientific achievements and extensive international relations. It is also the fruit of international cooperation that Hungary has been participating in certain international and European research infrastructures for many years. Apart from the long-established research relations, another important milestone for domestic researchers was the year 2015 when a comprehensive survey was conducted among the major representatives of higher education institutions and the academia on the needs of joining international research infrastructures. The survey was aimed at identifying the infrastructures Hungary should join in consideration of domestic research capacities, achievements, objectives and the expected socio-economic impacts of the membership. As a result, at the end of 2017 Hungary is participating in the research infrastructures shown in Table 1 as a full-fledged member, 16 of which were presented in the latest ESFRI Roadmap 2016.

Table 1: Hungary's membership in European research infrastructures

RI short name	RI name	ESFRI Landmark/Project	Type	Brief description
Environment				
DANUBIUS	International Centre for Advanced Studies on River-Sea Systems	Project	Distributed	**Hungary has observer status** in the project. It is expected to be operational in 2020. The aim is to support interdisciplinary research on the great river-sea systems (RS). It extends to environmental, social and economic research, and brings closer the various branches of environmental protection. It gives access to RS systems, related facilities and expertise facilitating the dissemination of knowledge and the coordination of data.
EPOS	European Plate Observing System	Project	Distributed	**Hungary has observer status** in EPOS. The EPOS project is in the implementation phase, expected to become operational in 2020. It will be capable of implementing innovative multidisciplinary research projects which aim to better understand physical and chemical changes causing earthquakes, volcanic eruptions, surface instabilities and tsunamis and determining the dynamics of the Earth's surface.
Health & Food				
ECRIN-ERIC	European Clinical Research Infrastructure	Landmark	Distributed	Supports the creation of a high quality, transparent, multinational system of clinical trials by mitigating the drawbacks of the fragmented clinical trial environment and poor interoperability.
ELIXIR	A distributed infrastructure for life-science information	Landmark	Distributed	This European initiative connects and integrates into a single infrastructure the major bioinformatics resources of national centres, hubs and services providers. It supports many fields of life sciences, including research in the field of agriculture and medicine.
EMBL	European Molecular Biology Laboratory	Not related to ESFRI	Distributed	One of the leading European laboratories in life sciences. It has 80 independent member research institutions covering the full spectrum of molecular biology from the molecule to the organism, including the fields of system biology and bioinformatics.
ERINHA	European Research Infrastructure on Highly Pathogenic Agents	Project	Distributed	Infrastructure network focusing on the examination and analysis of the properties and spreading of microscopic germs infecting animals and humans, and the public health, social and economic consequences of contagious diseases.
EuBI ERIC	European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences ERIC	Project	Distributed	Provides access to a wide range of state-of-the-art technologies in biological and clinical imaging. It aims to connect the specialised, geographically fragmented national hubs to reach all European researchers in the member states.
ICGEB	International Centre for Genetic Engineering and Biotechnology	Not related to ESFRI	Distributed	Every year, the ICGEB announces an open call for cooperative biotechnology research projects, for PhD and Postdoctoral fellowship applications, and for proposals relating to the organisation of conferences and training courses.
Physical Sciences & Engineering				
CERIC-ERIC	Central European Research Infrastructure Consortium, European Research Consortium	Not related to ESFRI	Distributed	The multidisciplinary research infrastructure integrates research projects in 7 European countries in the fields of materials science and nanotechnology at market price. The main focus of the consortium is open access (researcher exchange). Access is free of charge for commercial and industrial research projects.
CERN	The European Organization for Nuclear Research	Not related to ESFRI	Single-sited	The European Organization for Nuclear Research (CERN) is one of the most prestigious research centres in the world. Its main mission is basic research in particle physics with an aim to better understand the properties of basic interactions and the relationships of the universe. It designs, builds and operates complex particle accelerator equipment.

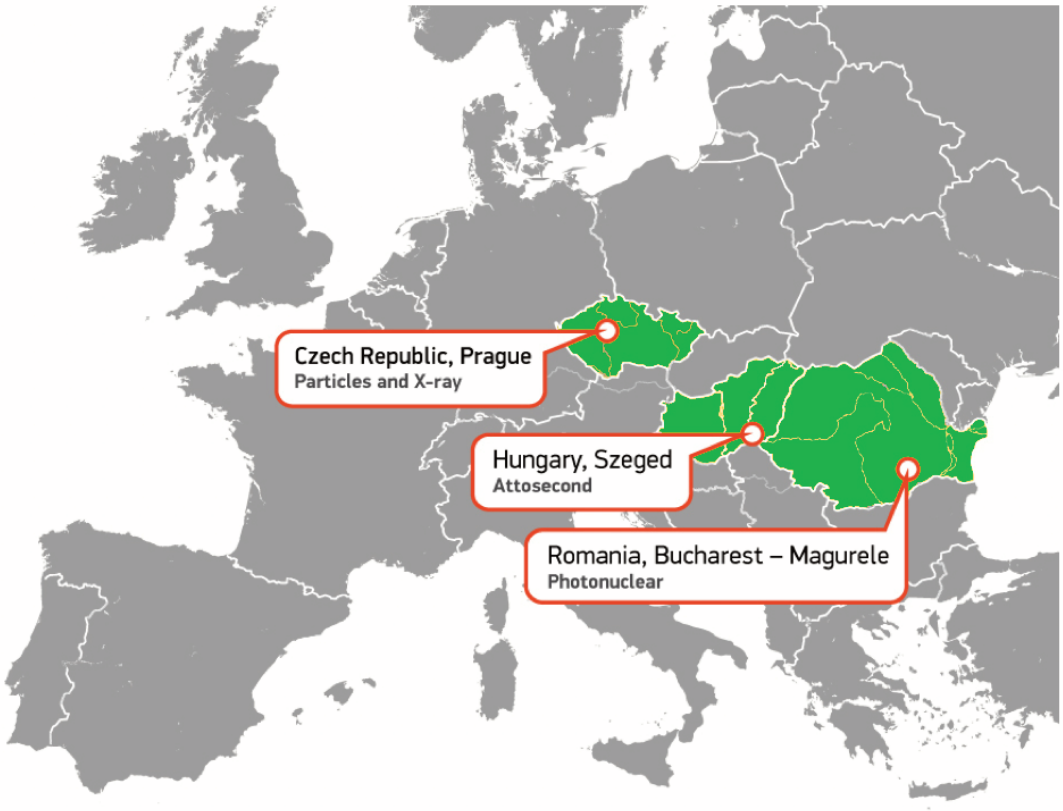
RI short name	RI name	ESFRI Landmark/Project	Type	Brief description
CERN HL-LHC (ALICE, CMS)	High-Luminosity Large Hadron Collider (CERN)	Landmark	Single-sited	The Large Hadron Collider (LHC) operated by CERN is going to be upgraded to increased intensity between 2019 and 2026. The detectors are also being upgraded: this work has already started in 2018. Of the four large detectors of LHC, Hungary participates in the experiments of ALICE and CMS. The CMS (and Atlas) project contributed to the discovery of the Higgs boson. The ALICE project recreates the primary matter through heavy-ion collisions.
ELI-ERIC	Extreme Light Infrastructure ERIC	Landmark	Distributed	The primary mission of the ELI Attosecond Light Pulse Source (ELI-ALPS) research infrastructure in Szeged is to provide access to a wide range of ultra-short light pulses sources for various user groups of the international scientific community. Another main element in the facility's mission is to promote the scientific and technological developments necessary for delivering lasers with high peak intensity and high average performance.
ESRF UPGRADES	European Synchrotron Radiation Facility (ESRF) Upgrades, Phase II: Extremely Brilliant Source	Landmark	Single-sited	The world's leading X-ray source. A state-of-the-art equipment enabling the atomic and nano-scale examination of matter in various fields of science: solid-state physics, medicine, pharmacy, earth sciences, environmental science and archaeology. There are many synchrotron sources across the world, but the ESRF is unique in terms of test beam parameters and the number of measurement channels.
ESS-ERIC	European Spallation Source ERIC	Landmark	Single-sited	ESS is the world's first so-called long-pulse spallation neutron source. Its mission is to build and operate a world leading facility for neutron research. The world's highest intensity neutron source enables the examination of systems which has never been possible due to the small size of the sample or the small intensity of the examined signal. The equipment gives a great boost to domestic research in physics, chemistry and materials science.
European XFEL	European X-Ray Free-Electron Laser Facility	Landmark	Single-sited	This facility is unique in Europe and is used for ultra-short (27 thousands/sec) and very bright X-ray experiments. With such parameters the facility opens up entirely new opportunities for scientific and industrial research. Researchers can map viruses at the atomic level, understand the molecular structure of cells, create 3D images of the nano-world , etc.
ITER/ EUROfusion	International Thermonuclear Experimental Reactor	Not related to ESFRI	Single-sited	The ITER aims to demonstrate that nuclear fusion can be used on Earth for energy purposes and testing technological solutions. ITER is considered unavoidable by competent researchers on the way to creating a fusion energy. Fusion related research and development is performed by EUROfusion program which integrates all member states' research projects in this field.
ESA	European Space Agency	Not related to ESFRI	Distributed	ESA is an international organization with 22 member countries, including Hungary. It is responsible for the planning and implementation of Europe's space programme. ESA programs are - designed to collect more information about the Earth and its immediate space environment, the Solar System and Space. It also develops satellite-based technologies and services, supports the space industry and facilitates the on-Earth application of technologies developed in space.
Social & Cultural Innovation				
CESSDA-ERIC	Consortium of European Social Science, Data Archives	Landmark	Distributed	The only virtual research infrastructures which provides a single interface to the social scientific databases of all EU member states and associated members. It is essential for the access and use of comparative social scientific databases for administrative and scientific purposes.
CLARIN-ERIC	Common Language Resources and Technology	Landmark	Distributed	A research infrastructure that provides advanced digital language resources and tools– primarily for scholars and social scientists. The CLARIN - ERIC was created by the merger of three ESFRI language technology initiatives. One of the founding parties was the Research Institute for Linguistics of the Hungarian Academy of Sciences, which still plays and played a leading role in the preparatory project as well.
ESS-ERIC	European Social Survey	Landmark	Distributed	ESS provides biannual comparative data about the demographic and social conditions of European societies, the changes in political and public preferences of citizens, and changes in social attitudes and action-guiding values. Data may significantly contribute to understanding changes in social behaviour taking place in Europe.
SHARE-ERIC	Survey of Health, Ageing and Retirement in Europe	Landmark	Distributed	SHARE is a multidisciplinary panel database of information on the health, use of the healthcare system, financial status and income, socio-economic background and social and family networks of more than 30,000 individuals aged 50 or older. The aim is to build up a database that allows for high-quality, fact-based decisions on issues related to aging.
E-RIHS	European Research Infrastructure for Heritage Science	Project	Distributed	The E-RIHS supports research activities aimed at the preservation, processing, documentation and management of cultural heritage. It provides state-of-the-art equipment and services for various research communities to better understand cultural heritage at global level. **Hungary has observer status.**
E-infrastruktúra/E-infrastructure				
PRACE	Partnership for Advanced Computing in Europe	Landmark	Distributed	PRACE is an international non-profit association. It comprises 24 member countries participating in the development of a super computer infrastructure. It provides world-class computing and data resources and services for large-scale scientific and engineering research projects.
GÉANT	Pan-European data network for the research and education community	Not related to ESFRI	Distributed	GÉANT connects national research and education networks across Europe. It provides a high-bandwidth, high-capacity network with an ever-expanding service, which enables the strengthening of cooperation between researchers. It gives highly reliable, unlimited access to calculations, analyses, storage, applications and other resources to ensure that Europe remains at the forefront of research.

Hungary also takes part as observer in the ACTRIS, , EU-OPENSCREEN and EST projects and in the FAIR and Life-Watch landmark.

Considering that the ELI-ALPS (Extreme Light Infrastructure Attosecond Light Pulse Source) is the only pan-European research infrastructure being implemented in Hungary which has ESFRI relevance, it is presented in more detail below.

The ELI-ALPS as a new European large research facility on the ESFRI Roadmap

The ELI (Extreme Light Infrastructure) high-power laser based research infrastructure is being established in European cooperation, with the involvement of the international scientific community. The ELI is the world's first facility to enable the examination of interaction between light and matter at unprecedented intensities, even in the so-called ultrarelativistic range. This can open new doors in physics and can lay the foundations of new technical developments, such as relativistic microelectronics and compact (desktop size) laser particle accelerators. The research infrastructure indicated in the E*SFRI Roadmap* is being commissioned continuously from the end of 2017.



The laser research centre is built on three sites in Hungary, the Czech Republic and Romania at the same time, subject to joint coordination and a harmonised research strategy. The ELI Attosecond Light Pulse Source (ELI-ALPS) research institute (Szeged, Hungary) hosts experiments on extremely short processes unfolding in atoms and molecules; the ELI-beamline (Czech Republic) focuses on generating short-pulse X-rays and on particle acceleration; and the ELI-NP (Romania) examines fundamental nuclear questions with ultra-powerful optical and gamma pulses . The three pillars will be integrated into a unique, international, multi-site facility by ELI-ERIC, enabling users to have access to all three research capacities through a single call for proposal. The first call ('zero call'), which will establish and test the access process and support of users and the expert evaluation system, is planned to be announced in 2018.

The shared implementation of the facility in Central and Eastern Europe will, on the one hand, facilitate Europe's leading role in a rapidly evolving strategic sector, and on the other hand, accelerate the mitigation of existing differences in research, technological and human resources. The implementation of the research centre is considered as a flagship by the European Union because it is a notable example of how the Structural Funds, the H2020 funds and national resources can be used in a complementary way.

The ELI-ALPS equipment primarily enables basic research in physics, chemistry, materials science and biomedical sciences, but it will also be used for applied research and – as a spill over effect – for industrial application purposes.

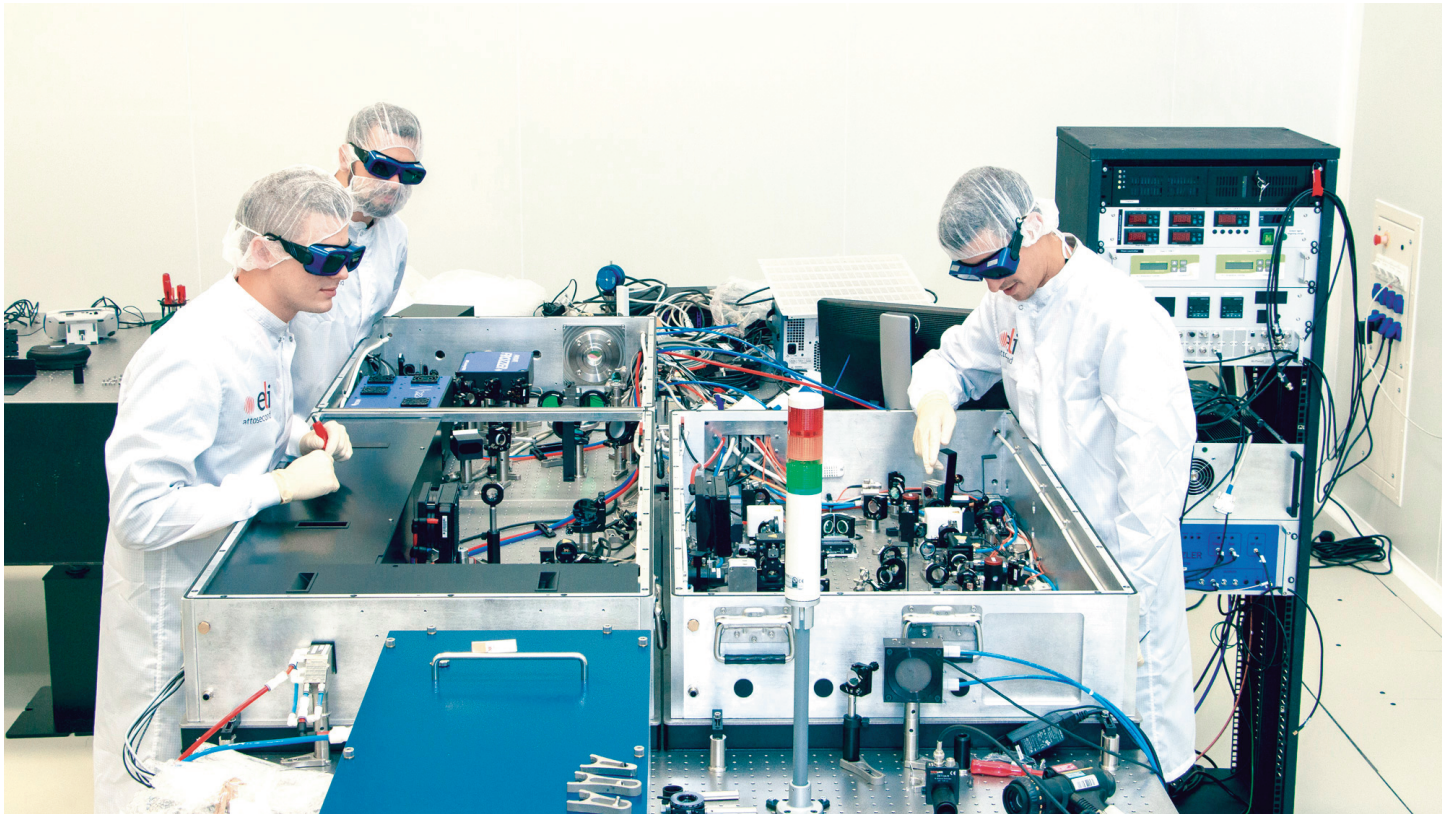


Figure 2: The Mid-Infrared (MIR) Laser

4. The development and funding of research infrastructures

Act LXXVI of 2014 on scientific research, development and innovation (hereinafter: "RDI Act") stipulates that *"the Government performs all tasks related to the public funding of research, development and innovation primarily through the National Research, Development and Innovation Office (hereinafter: 'NRDI Office') to ensure that the supervision of research, development and innovation is based on harmonised legal practice and that funds available for research, development and innovation are spent efficiently" and that "the Government provides public funding to research, development and innovation primarily from the National Research, Development Fund (hereinafter: 'NRDI Fund')."*

According to the RDI Act: *"the purpose of the NRDI Fund is to provide a secure and predictable source of funding to encourage and fund research and development and economically exploited innovation, help strengthen research and development that bears fruit in the economy and in other areas, help exploit Hungarian and foreign research results and improve the research, development and innovation infrastructure and related services.".*

The NRDI Office funds the development of domestic research infrastructures and memberships in international research infrastructures from the NRDI Fund, through chapter-managed appropriations.

The establishment and extension of research infrastructures , and the funding of ESFRI memberships may take place through various **funding mechanisms**.

- The ELI large research infrastructure, which is unique even by international standards, is funded as a priority state project partly from domestic and partly from EU sources (European Structural and Investment Funds (ESIF)), the European Regional Development Fund (ERDF) and the EU's framework programme for research and innovation (Horizon 2020).
- The establishment and development of smaller domestic research infrastructures (RIs) are funded in the framework of various targeted competitive funding programmes and schemes. Depending on geographical location and goals, projects may get funding domestic sources or from the European Structural Funds.
- In addition, research institutions and higher education institutions establish and develop RIs from own funds or in co-operation with businesses.
- Membership fees related to participation in ESFRI projects and landmarks are paid in accordance with the terms of the agreement concluded for the given RI. Membership fees are financed from the chapter-managed appropriations, through the contribution of contribution paid the NRDI Office.

The responsibility of operating a given unique research infrastructure primarily lies with the research institution or higher education institution which created it. To secure their sustainability, domestic RIs have to be operated with openness and by strengthening cooperation. This is facilitated by the classification of RIs into infrastructure groups. The extensive external use of RIs in a regulated environment is very important both in terms of internationality and for the involvement of the business sector: it ensures that RI capacities are used widely and efficiently and provides additional sources of income for covering operation and further development costs.

In addition to the NRDI Fund's contribution, **it is an aim that international membership fees** are paid to the largest possible extent from the own resources of the research and higher education institutions involved in the given international research infrastructure. Another aim is to increase the share of Hungary's **in-kind contributions** in paying the international membership fees.

Since 1 January 2015, when the NRDI Office was established, several funding programmes have been launched in Hungary to stimulate RDI activities. These programmes were mainly aimed at developing research infrastructures, promoting knowl-

edge sharing and international cooperation, and fostering corporate innovation. Below we name the most important funding schemes supporting the expansion and development of **Hungarian research infrastructure capacities**:

• **Excellence of strategic R&D centres** (funded from the Structural Funds – GINOP-2.3.2-15, VEKOP-2.3.2-16)
The call aims to strengthen the R&D capacity of domestic, state-operated knowledge bases in order to facilitate high-quality, internationally acclaimed research output and create sustainable centres of excellence
Number of funded projects: 63. Total awarded funding: HUF 68,265 million.

• **Strengthening research infrastructures – internationalisation, networking** (funded from the Structural Funds – GINOP-2.3.3-15, VEKOP-2.3.3-15)
The call aims to strengthen international research cooperation through the development and network of research infrastructures, and to enhance and secure the international competitiveness of centres of knowledge in order to produce internationally high-rated research results.
Number of funded projects: 62. Total awarded funding: HUF 27,050 million.

• **Centre for Higher Education and Industrial Cooperation – Research infrastructure development** (funded from the Structural Funds – GINOP-2.3.4-15)
The call supports such organisational forms of industry-higher education cooperation which are suitable for creating RDI capacities that meet the needs of industrial partners, developing competitive products and services, and upgrading production technologies that secure or improve the marketability of the relevant products at the partner companies.
Number of funded projects: 5. Total awarded funding: HUF 26,863 million.

• **Centre for Higher Education and Industrial Cooperation– Research infrastructure development** (funded from the NRDI Fund – FIEK_16)
The call is open to consortia built on stable industry-university partnerships that have been operating successfully for several years and provides funding for the development of RDI relationships in a funding scheme that ensures a long-term sustainable, results-oriented framework for innovation activity in institutionalised cooperation, based on excellence and financial stability.
Number of funded projects: 3. Total awarded funding: HUF 7,944 million.

• **National Competitiveness and Excellence Programme** (funded from the NRDI Fund– NVKP_16)
The call, which was open to consortia of domestic higher education institutions, research institutions and businesses, supports research, development and innovation activities of strategic importance for Hungary's competitiveness, including in particular the creation of marketable products, services or technologies with great added value in one of the following areas:

- Sub-programme "A": National Programme greatly improving the efficiency of curing high mortality risk diseases
- Sub-programme "B": Materials Science and Technology National Programme;
- Sub-programme "C": Water–Health–Food National Programme.

Number of funded projects: 26. Total awarded funding: HUF 27,984 million.

• **National Excellence Programme** (funded from the NRDI Fund– NKP_17 and 2018.1.2.1-NKP)
The NRDI Office facilitates the social and economic utilisation of discovery research findings by defining strategic areas where Hungary has sufficient researcher excellence for performing the tasks, making it possible to reach the goals faster and more efficiently. These initiatives involve research activities addressing large-scale interdisciplinary scientific and technological challenges which, due to their comprehensive nature and volume, can be implemented through long-term cooperation between scientific, industrial and social stakeholders and decision-makers.

Project name	Objective	Amount of funding (HUF)
National Excellence Programme (NKP_17)	Support of initiatives that involve research activities addressing large-scale interdisciplinary scientific and technological challenges which, due to their comprehensive nature and volume, can be implemented in long-term cooperation between scientific, industrial and social stakeholders and decision-makers. • Sub-programme "A": National Brain Research Programme • Sub-programme "B": National Quantum Technology Programme	10 billion
National Excellence Programme (2018.1.2.1-NKP)	Support of RDI projects implemented in consortia involving extensive cooperation between universities, research institutions and the industry but led by universities or research institutions partly adopting a top-down governance and coordination. • Sub-programme "A": ELI Related Experimental Research National Programme • Sub-programme "B": Artificial Intelligence in Application National Programme • Sub-programme "C": Secure Society National Programme • Sub-programme "D": "Clean Drinking Water" National Programme • Sub-programme "E": Protein Science and Applications National Programme	5 billion

• **Implementation of the ELI laser research centre** (ELI-ALPS) large project, Phase 2 (funded from the Economic Development and Innovation Operational Programme – GINOP-2.3.6-15)
The call finances the second implementation phase of ELI Attosecond Light Pulse Source (ELI-ALPS), the Hungarian large project forming part of the distributed Extreme Large Infrastructure, ELI) proposed in the ESFRI Roadmap. Once completed, the ELI-ALPS large project will put Hungary and - Central and Eastern Europe on the "ERA map" and can help increase Europe's role in the global R&D sector. The successful implementation of the project is of tremendous importance for the entire Hungarian research and development ecosystem.
Number of funded projects: 1. Total awarded funding: HUF 40,052 million]

• **Research infrastructure development projects funded under the H2020 framework programme**
H2020 is the EU's framework programme for research and innovation which also announces targeted calls for research infrastructure development projects, where Hungarian research groups are successful. Many Hungarian institutions take part in such projects and the ELI is also among the beneficiaries of H2020 funds.
Number of funded projects: 29. Total funding awarded to Hungarian partners: EUR 5.183 million (≈ HUF 1586 million)

5. Monitoring and evaluation

The **monitoring and evaluation process** is an integral part of the National Roadmap and of the system of domestic research infrastructures. Monitoring is needed primarily for the following reasons:

- The drafting of the National Roadmap was not a one-time task. In order to follow the changes in domestic scientific life, both the document and the inventory of domestic RIs need to be updated regularly. The regular update calls for information and quantified data.

- One of the most important characteristics of RIs is that their function serves long-term goals. Thus, the operation and financing of the domestic system of research infrastructures can only be stable and predictable, if sustainability aspects are duly considered. In order to underpin this, the existence of monitoring indicators is inevitable.

- The research infrastructures have fundamental effects on the quality of scientific results. So, the establishment and operation of RIs not only provide excellent professional opportunities for researchers but also come with responsibility. The technological level of RI instruments, equipment and databanks and the resultant high costs require responsible financial management from all stakeholders in the research infrastructure system. To this end, the RI system must be operated in a way that ensures that the development of domestic RIs and the funding of memberships in international RIs are in compliance with domestic research needs and capacities. A sound monitoring system can greatly support the effective operation of the research infrastructure system.

- Memberships in large European and international research infrastructures also demand substantial resources. Such memberships need to be revised every 3-5 years based on the information and indicators available for the scientific outputs of the RI. Importantly, research groups with a high research potential and significant scientific achievements should be allowed to join European research infrastructures as new users. At the same time, to ensure professional excellence, it is also fundamental to fully exploit existing memberships and continuously monitor the effectiveness.

- The continuous monitoring of the financial support and development strategy making activities of the government agencies responsible for infrastructure development and monitoring is also essential to ensure the effective operation of research infrastructures. To this end, efforts must be made to increase the efficiency and reduce the time frame of public procurement procedures, align RI funding strategies and tools, and efficiently disseminate new scientific results and improved methodology both in Hungary and abroad. It is also important to align the development of research infrastructures with national R&D strategies and the National Smart Specialisation Strategy (S3).

Monitoring tasks related to research infrastructures are interpreted in three dimensions:

1. The establishment and operation of the ELI has demanded and will continue to be demanding vast (EU and national) resources so it is definitely justified to monitor and evaluate the efficient use of funds in order to inform the research community, the taxpayers and the policymakers.
2. The second dimension of monitoring is memberships in large European and international research infrastructures. Here the main aim is to constantly monitor the capacity utilization, effectiveness and integration into the life of domestic research communities of memberships in international RIs.
3. Finally, it is important to monitor the status and scientific performance of local domestic RIs and to revise the existing RI databases. Among other things, this provides a basis for the regular update of the *National Roadmap* and for future directions of infrastructure development.

The three dimensions require different depths of monitoring. **The *National Roadmap* is not intended** to provide a detailed description of the monitoring system in relation to domestic RIs or international memberships. However, there are some clearly definable policy indicators, which **play key role** in the description of RI performance. Importantly, indicators are expected to fit with the indicator system used in the S3 and the RDI Strategy, as well as with international methodologies to ensure international comparability. The brief presentation of the key policy indicators can be informative for those who are already or will be working in the context of research infrastructures. These topics will be highlighted below.

Detailed monitoring tasks related to the ELI must primarily follow the ESFRI methodological requirements but they are not described in detail in the National Roadmap.

As regards the monitoring of memberships in ESFRI research infrastructures, the following aspects are considered important:

- the number and name of institutions and organisations represented by the researchers using the international research infrastructure;
- the number of Hungarian researchers/PhD students using the international research infrastructure;
- the number of new publications resulting from the use of the international research infrastructure;
- the number of ongoing international research collaborations implemented in the framework of the international RI;
- international research cooperation or project established with new actors in the research sector using the RI.

The monitoring of the domestic research infrastructures primarily focus on the following areas:

- scientific excellence and achievements of the researcher community around the RI;
- the international relations and network for research cooperation developed by the researcher community;
- the interdisciplinarity of the researcher community of the RI;
- the level of integration with education;
- the openness of the RI;
- the innovation potential of the RI (number of industry cooperation projects and patents);
- the financing model and sustainability of the establishment and operation of the RI.

6. RI development directions and strategic objectives

The only way for Hungary to become an active participant in international research cooperation is to seek excellence in the field of infrastructure development as well. The *National Roadmap* gives us a fair view of the current situation of Hungarian research infrastructures, as well as the strengths and problems relating to their operation. This provided the foundations of setting the **strategic medium-term objectives** for RI operation as follows:

1. boost the competitiveness of research infrastructures, with particular focus on the priority areas specified in the strategies and on European research directions;
2. promote the domestic networking of R&D infrastructures;
3. facilitate connection to major international infrastructures and networks;
4. improve the utilisation of RI capacities through cooperation;
5. make the register of research infrastructures public and ensure access to free capacities.

Policy considerations

It is important to **strengthen the policy coordination of research infrastructures** for the better utilisation of available financial resources, increased policy relevance and acknowledgement of research infrastructures, and the more efficient exploitation of memberships in international research infrastructures.

Furthermore, awareness-raising, information and knowledge-sharing opportunities should be grasped more effectively to raise Hungarian researchers' awareness of international research infrastructures and thus encourage them to strive for scientific excellence.

Internationalisation

Increased internationalisation is a primary focus in relation to research infrastructures. Participation in international research networks is a prerequisite for stimulating efficient and quality-oriented research. International cooperation also enables Hungarian researchers to join international ESFRI research infrastructures.

In terms of memberships in international RIs, it is recommended to develop a transparent preparation process and a set of assessment criteria that ensures the efficient, sustainable and excellence-based use of infrastructure memberships and enables membership in newly established international RIs. As to international membership fees, Hungary should seek to avail the opportunity of in-kind contributions to the fullest possible extent. To this end, existing memberships should be revised every 3-5 years.

Among the strategic objectives, top priority is given to the use of the capacities of the **ELI large research infrastructure,** which facilitates Hungary's active participation in international research in **several fields of science.**

Cooperation

Reduced isolation and increased openness of domestic RIs are vital for effective and quality-focused research. In this respect, the change of mentality is as important as the establishment of appropriate research infrastructures.

The rapid technological shifts in the last decades have fundamentally changed the operation of the research sector. This calls for better (technological, digital) skills and **more multidisciplinary research projects.** To ensure that domestic research capacities and researchers stay in the international frontline, it is essential to foster **problem-oriented collaboration** between research groups and researchers working in different fields.

It was a definite goal of creating RI groups to **strengthen cooperation and networking between individual RIs, make local RIs** more open and better utilise available human resources. By further reinforcing existing collaborations and enabling new ones, RI groups can greatly contribute to a **self-organising, problem-oriented and open scientific community.**

Such cooperation is actively facilitated by the special background infrastructures which take advantage of the increasing prevalence of digital technology and the emergence of new forms of scientific communication to ensure **open access to scientific results** (Open Access).

Sustainability

The National Research, Development and Innovation Strategy, which is currently being revised, fosters the importance of continuous and **predictable long-term financing and performance-based operation.** In this regard, it is particularly important to ensure the uninterrupted and reliable financing of highly valuable research infrastructures that are essential for international research (such as ELI).

To ensure the sound operation of RIs, **scientific excellence should be set as a requirement in the relevant funding schemes.**

Also, to ensure long-term sustainability of individual RIs it should be set as a goal to increase their openness to stakeholders from private sector. A sound and sustainable system of domestic research infrastructures also calls for **effective monitoring and evaluation culture.**

To ensure long-term sustainability, RIs have to be encouraged to **develop better management, organisation and coordination skills** and to prepare well-grounded development and sustainability plans.

Socio-economic effects

Greater emphasis should be placed on the **innovation potential** of research infrastructures, on openness, and on more efficient exchange of knowledge with the business sector to improve competitiveness and ensure the long-term sustainability of research infrastructures. In addition to maintaining excellence, RIs also play an important role in training the next generations of researchers and in education by cooperating with universities.

Besides industrial cooperation, RIs should also be encouraged to **take up social responsibility more consciously.** Research infrastructures are the foundations of the domestic research base, so they have a central role in addressing social, economic and environmental issues. The dissemination and improved social acceptance of the knowledge generated by research groups are thus the joint responsibility of policy-makers and the domestic research communities.

7. Categorisation of RI groups by ESFRI thematic areas

In the categorisation of domestic RI groups, for the sake of easier identification of international connections, **the ESFRI recommended thematic areas were used, adjusted to national specificities.**

Table 2: RI groups by ESFRI thematic areas

ESFRI classification by scientific field (6)	Research infrastructure networks (groups)	Name of coordinator institution
ENERGY	**Energy research**	HAS Centre for Energy Research
ENVIRONMENT	**Atmosphere**	University of Pannonia
	Hydrosphere	Eötvös Loránd University
	Geosphere	HAS Research Centre for Astronomy and Earth Sciences
	Biosphere, ecology and agriculture	HAS Centre for Ecological Research
HEALTH AND FOOD SCIENCES	**Biobanks and animal houses**	Semmelweis University, Institute of Genomic Medicine and Rare Disorders
	Clinical Medicine Research HECRIN Network	University of Pécs, Szentágothai Research Centre
	Medical imaging research Euro-BioImaging Network	University of Debrecen
	Bioinformatics ELIXIR-HU Network	HAS Research Centre for Natural Sciences, Institute of Enzymology
	Biomolecular interactions, structural biology and molecular imaging	HAS Research Centre for Natural Sciences, Eötvös Loránd University
	Agriculture and food research	HAS Centre for Agricultural Research
PHYSICAL SCIENCES AND ENGINEERING	**Particle physics**	HAS Wigner Research Centre for Physics
	Nuclear physics, atomic physics and their applications	HAS Institute for Nuclear Research
	Astronomy, space research	HAS Research Centre for Astronomy and Earth Sciences, Konkoly Observatory
	Materials science research	Eötvös Loránd University
	Solid state physics research	HAS Centre for Energy Research
	Laser-based research and ELI-ALPS	HAS Wigner Research Centre for Physics and ELI-HU Nonprofit Kft
	Vehicle and transportation engineering	Budapest University of Technology and Economics Department of Automotive Technologies
	Industry 4.0	HAS Institute for Computer Science and Control

ESFRI classification by scientific field (6)	Research infrastructure networks (groups)	Name of coordinator institution
SOCIAL AND CULTURAL INNOVATION	**ESS-HU Network (European Social Survey)**	HAS Centre for Social Sciences
	SHARE HU Network (Survey of Health, Ageing and Retirement in Europe)	HAS Centre for Economic and Regional Studies
	CESSDA HU Network (Consortium of European Social Sciences Data Archives)	HAS Centre for Social Sciences
	HUNCLARIN Network (Common Language Resources and Technology Infrastructure)	HAS Research Institute for Linguistics
E-INFRASTRUCTURES	**E-infrastructure**	Government Information Technology Agency
	5G	Budapest University of Technology and Economics, Centre for Higher Education and Industrial Cooperation

One of the main factors of developing research infrastructures and creating groups was to support the strategic directions and priorities specified in the National Smart Specialisation Strategy (S3) and the RDI Strategy.

In addition to reflecting the national characteristics and policy requirements, the RI groups also **follow the international trend** of putting more emphasis on the complex approach to problems, horizontal aspects, interdisciplinarity and data management, as well as on translating data analysis, networking and research outputs into practice. There also appears to be a general **shift of focus** between research fields, which can also be perceived in a domestic context. For instance, research infrastructures in chemistry have penetrated into the relevant RI groups of the Environment, Health Sciences, Physical Sciences and Engineering, and Energy thematic areas. Agriculture and food research are separated for policy considerations: due to its substantial environmental impacts agriculture is now put into Environment, and food research into Health and Food Sciences.

In the following the ESFRI thematic areas will be used to **present the domestic RI groups** which involve several research groups and are thus especially important in the given field of science, enable international-quality research, contribute to solving strategic problems, perform internationally outstanding research activities, and actively take part in European initiatives and cooperation projects.

7.1. Energy

Energy science is massively interdisciplinary. The main task of energy scientists is to collaborate with energy technicians to supply the national economy, or, from a local perspective, the localities and households with secure, economical and environmentally friendly energy and, to this end, to research and develop sustainable energy production, transformation and storage systems. They are also responsible for the scientific examination of the stability, the sustainability and the environmental and social impacts of energy systems, and for assisting the work of policy-makers.

Scientific fields and subfields relating to energy science require multidisciplinary competences. As individual researchers seldom have all the necessary knowledge and skills, teamwork and the use of multiple research infrastructures are essential for success.

If the development of an energy transformation, saving or storage system calls for new materials or processes, scientists perform basic research. For the characterisation of the materials and the better understanding of the processes, however, scientists will need applied research, primarily analytics. Large and complex RIs are mostly used for such analytical research. Both research and the examination of compatibility with the energy system rely on data from several databases: for the former, databases include data on the properties of materials and of finished products, while for the latter, they include data on users, typical forms of use, environmental conditions, distribution and characteristics of renewable energy potentials, production and distribution routes.

Due to its size and population, Hungary has only relatively few energy research infrastructures. One of the most significant domestic RIs focuses on nuclear energy (fission and fusion). There is high demand for RIs in the transformation of materials resulting from bioenergy research through catalytic and electrochemical processes, in laying the foundations of hydrogen economy and in experimental research on fuel cells and electrical energy storage. Further important fields of research include photo-and electro-chemical research, solar cell research, research on the cultivation and use of energy crops and trees, research on woody energy crops, research on traditional and bio-hydrocarbons, as well as geothermal and nuclear energy research. Academic institutes and the largest universities contribute to all these fields.

The examination of the entire life cycle, and the economic, environmental and social impacts of energy systems, and government-level decisions heavily rely on data from databases which are currently rather incomplete. This is why database-type research infrastructures need to be set up and continuously maintained. The capacities enabling research on energy storage facilities, especially battery research and the production of raw chemicals using renewable energy, should also be improved. This also calls for the conscious training of competent workforce.

7.1. ENERGY

ENERGY RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group

The research infrastructure (RI) group covers a broad spectrum of energy science research from discovery research to research, development and innovation. Energy science includes the areas of physical, chemical, geological, environmental, engineering, meteorology, biological, agricultural, social, economic and decision science that promote sustainable and environmentally friendly energy production, utilisation, storage, saving and distribution.

The RI group aims to perform RDI tasks that can be utilised in the energy sector. It is also important to explore and apply the widest possible range of competencies.

National coordinator of the RI group:
Centre for Energy Research, Hungarian Academy of Sciences (MTA EK); Budapest Neutron Centre (BNC)

Contact: Tamás Belgya
E-mail: belgya.tamas@energia.mta.hu
Website: http://www.energia.mta.hu/hu; http://www.bnc.hu

Partners: MTA AEKI, CODEX (EC) nuclear power plant – major accidental fuel damage simulating laboratory; MTA EK AEKI nuclear power plant – full-scale and engineering simulator laboratory; MTA EK AEKI – PMK2 – nuclear power plant – primary cycle water loop equipment; MTA EK AEKI – CERES – reactor vessel – external cooling experimental equipment; MTA EK AEKI – WAHA – water hammer experimental equipment; MTA EK EKBI – PGAA-NIPS, RAD and NAA equipment; MTA EK EKBI – Surface Chemistry and Catalysis Department; MTA EK EKBI – vitrification laboratory, material testing and elemental analysis laboratory (PSD, XRF equipment); MTA EK EKBI – hybrid energy storage system testing laboratory; MTA EK MFA – Microtechnology Laboratory, experimental solar cell test equipment; MTA TTK AKI – Renewable Energy research infrastructure group; MTA Wigner FK Department of Plasma Physics, fusion research; SE EMKI – biomass pilot infrastructure; ME GIK Department of Fluid and Heat Engineering; ME GIT – Geothermal Energy Laboratory; BME NTI Educational Reactor; BME NTI PIV Laboratory; BME NTI Radiochemical and Nuclear Analytical Laboratory; BME NTI Fusion Research Group; DE TTK Nuclear Security and Technical Laboratory; BME VET Smart Grid Research Laboratory; BME VET High-Voltage Laboratory; BME VET Electric Machines and Drives Laboratory; BME Department of Automation and Applied Informatics; BME EGR György Jendrassik Thermal Laboratory; BME EGR Renewable Energy Laboratory; PE biofuel development for micro- and large reactor systems

ESFRI connection: CERIC-ERIC; ESS-ERIC; MYRRHA; E-RIHS; ILL

Status of the RI group: early stage of building collaborative relationships

Background information

The RI group is coordinated by MTA EK. One of its institutes is leading the domestic nuclear energy research. The EK's other two institutes engage in dynamically developing alternative energy research. The EK has initiated the mapping of domestic research infrastructures in energy research and the collection of relevant information. This allows for the creation of a wide energy research platform that can address complex tasks.

Half of the RIs listed in the Partners section belong to one of the three EK institutes. EK institutes intensely cooperate with each other, for example in neutron physics research (BNC). The EK takes part in joint research projects, collaborating with domestic universities and several institutes of the HAS. Together with MTA TTK AKI it is a member of the Ányos Jedlik Cluster. The EK participates in a number of EURATOM, OECD NEA, ITER, ESS ERIC, CERIC-ERIC and IAEA programmes. In addition to the listed ones, there are further institutions in Hungary which deal with the energy research but they have no significant research infrastructures.

Aim of the RI group

The RI group aims to intensify relations and exploit synergies. An important goal is to find alternative ways for renewable energy storage and saving with the greatest possible efficiency and flexibility even in the long run. These technologies can contribute to the reduction of carbon dioxide emissions so in the next 2-3 years research will develop into these directions which requires further infrastructure development. The long-term preservation of nuclear energy in the energy mix is also important, which again requires infrastructure development. Specific development proposals include: an experimental passive cooling system (PMK3), a high temperature fuel and structural material-development laboratory and a decommissioning knowledge centre. The RI wishes to build relationships and make both the new and existing infrastructures open access.

7.2. Environment

The "Environment" ESFRI category is inherently characterised by interdisciplinarity, this is why it more or less overlaps with the other five ESFRI categories. The topics of natural resource-based energy, health and food science, and social and cultural innovation all have environmental implications, while the research infrastructures of physical sciences and engineering are essential for the testing of environmental materials.

Interdisciplinarity is present within the Environment category as well. Topics are broken down by atmosphere, hydrosphere and biosphere, but there are connections and interactions between many of these spheres, which is best exemplified by the complex topic of climate change. Extending the scope of the Environment ESFRI category, the atmosphere, hydrosphere, biosphere and geosphere is interpreted as the complex geo-bio environment and where bioshpere also includes soil, ecology and biodiversity.

Hungary is not expected to participate in all projects, landmarks and ERICs of the Environment ESFRI category as a full member country, but Hungarian researchers and research groups are present in some form in most of the infrastructures. Hungary is a participant in the ACTRIS, DANUBIUS-RI and the EPOS ESFRI projects and the LifeWatch ESFRI landmark. Hungarian research infrastructures have been substantially developed in recent years from cohesion and national funds, so substantial improvement and increased international cooperation are expected in environmental science as well.

7.2. ENVIRONMENT

ATMOSPHERE MONITORING VIRTUAL RESEARCH CENTRE RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group

The group operates an aerosol research and education platform (BpART) in Budapest for the purpose of identifying, understanding and characterising interactions between particles and urban air environment, and determining the medical, climatic and other environmental consequences of aerosol formation processes, particularly atmospheric nucleation using advanced experimental and evaluation methods. They developed a four-wavelength photoacoustic aerosol monitoring system for the real-time measurement of the optical absorption spectrum of aerosol particles. They also developed a family of aerosol size distribution and concentration measurement instruments based on laser optics. They use new MICADAS accelerator mass spectrometry (AMS) extended with a multifunctional sample preparation and gas handling system to identify the source of aerosol particles by 14C/12C isotope ratio measurement. Urban aerosol pollution is monitored in the long- and short-term with sampling, analysis and model calculation. Automatic gas analysers and meteorological sensors are fitted on TV towers to determine the concentrations of greenhouse gases and their vertical fluxes between the biosphere and the atmosphere. The infrastructure is one of the priority greenhouse gas measurement station of the European Union, and is also part of the Global Atmosphere Watch (GAW). In the geophysical observatory, continuous atmospheric electricity, ionosphere and magnetosphere measurements take place. The installed micrometeorological and trace gas measurement system are used to determine the nitrogen cycling between various ecosystems. A HRPT (High Resolution Picture Transmission) receiving station is operated to receive the data of Earth observation satellites. The background air pollution monitoring station is used by an international project to measure the size distribution and concentration of atmospheric aerosol, the chemical composition and radiation transfer properties of aerosol particles and precipitation, and the mixing ratio of trace gases. The RI group also operates a system suitable for measuring fog properties, and is developing an air pollution forecasting system which takes into account interactions between atmospheric water and aerosol particles.atmospheric water and aerosol particles.atmospheric water and aerosol particles.

National coordinator of the RI group:
University of Pannonia

Contact: András Gelencsér
Email: gelencs@almos.uni-pannon.hu
Website: https://levegokemia.uni-pannon.hu/

Partners: ELTE; PE; SZTE; MTA Wigner FK; MTA Atomki; OMSZ; Max Planck Institute for Chemistry; NOAA; University of Helsinki; Ghent University; Forschungszentrum Jülich; ICOS ERIC; Norwegian Institute for Air Research; JRC ISPRA; IAEA

ESFRI connection: ICOS
Status of the RI group: operating network

Background information

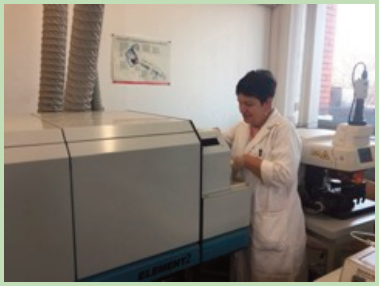
BpART, http://salma.web.elte.hu/BpArt), K-sheer (http://www.met.hu/levegokornyezet/hatterszennyezettseg/merohalozat/k-puszta/) background air pollution monitoring station, accelerator mass spectrometer, greenhouse gas volume and vertical flux measurements, aerosol optical measurement systems, high-altitude observations.
International projects: CARBOSOL [FP7], CHIOTTO [FP5], CarboEurope [FP6], IMECC [FP6], InGOS [FP7], RINGO [Horizon2020], EMEP (CLRTAP), FAIRMODE

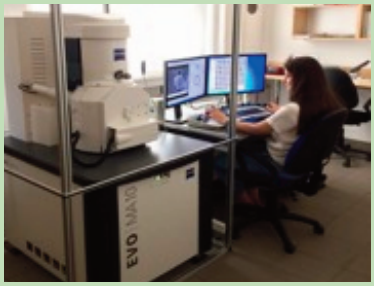
Aim of the RI group

Better understanding of the role of aerosol particles and atmospheric nucleation in the air quality in Budapest and the Carpathian Basin; identification of the additional health risk of ultrafine particles; examination of the long-range transport and role of atmospheric aerosol particles and trace gases in climate modification; and the more accurate characterisation of complex atmospheric aerosol sources.

7.2. ENVIRONMENT

HYDROSPHERE RESEARCH INFRASTRUCTURE GROUP





Presentation of the RI group

The Carpathian Basin as a catchment area plays a major role in the water management and environmental protection of Central Europe. The research and development activities of existing infrastructures in the region are coordinated by DANUBIUS-RI, a forming pan-European initiative.

Several Hungarian institutions perform world-class research on continental surface waters. This work includes the measurement of water quality; the routine execution of complex research ensuring water security; environmental and nature protection focused expert support for social interventions affecting aquatic habitats and wetlands; multilevel examination of aquatic invertebrates and cold blooded vertebrates; chemical and biological qualification of surface waters; examination of sediments; characterisation of chemical and microbiological health risks of drinking water, bathing water and therapeutic water. Important research areas: sustainable water and river basin management; geothermal energy utilisation; hydrogeochemistry; karst hydrogeology; ground water-related disaster management issues; research on basin water flow systems to better understand the processes of shallow and deep water resources; biological and mineralogical research on epigenic and hypogenic karts, caves and precipitations; and natural radioactivity in waters and precipitations.

Research tasks especially include the processing and interpretation of measured and archive data; stationary and transient fluid and heat transport modelling; time series research; hydrodynamic and transport modelling; development of monitoring systems; and environmental risk analysis.

National coordinator of the RI group:
Eötvös Loránd University, Cooperative Research Centre for Environmental Sciences

Contact: Gyula Záray
Email: zaray@chem.elte.hu
Website: http://kkkk.elte.hu/

Partners: Centre for Ecological Research, Hungarian Academy of Sciences, Balaton Limnological Institute; and Danube Research Institute; National Institute of Environmental Health; Hungarian Mining and Geological Service, Hydrogeology Department; Eötvös Loránd University, Institute of Geography and Earth Sciences; University of Szeged, Hydrogeology and Geothermal Research Group; University of Miskolc Institute of Environmental Management; Széchenyi István University; Budapest University of Technology and Economics, Department of Hydraulic and Water Resources Engineering

ESFRI connection: DANUBIUS-RI

Status of the RI group: under implementation

Background information

Széchenyi István University, Eötvös Loránd University, Institute of Geography and Earth Sciences and Centre for Ecological Research, Hungarian Academy of Sciences ,Duna Research Institute take part in the preparatory stage of the DANUBIUS-RI project. DANUBIUS-RI brings together research infrastructures dealing with European river–sea systems by developing them and establishing new analytical, monitoring and data modelling centres.

Aim of the RI group

Participation in the development of methods for the evaluation of ecological conditions and in the evaluation of the ecological condition of our waters in line with the EU VKI River Basin Management Plan, and participation in the Joint Danube Survey projects. To keep track of the biological and chemical changes in the water ecosystem, the currently highly fragmented infrastructure needs to be further developed. To this end, we need to provide central laboratories for hydrology research groups engaging in surface water and ground water research at national level, where they can address issues in hydrogeology, hydrobiology, water and sediment chemistry, by using large research equipments such as scanning and transmission electron microscopes, mass spectrometers, high pressure permeabimeters, infrastructure for molecular biological investigations, etc.

7.2. ENVIRONMENT

GEOSPHERE RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group

Geosphere research is performed in three MTA CSFK institutes, namely the Geodetic and Geophysical Institute, the Institute for Geological and Geochemical Research and the Geographical Institute, in certain domains in collaboration with the Konkoly Observatory. From the institutes of the Hungarian Academy of Sciences, MTA Atomki and MTA Wigner FK also play a major role in geo-environmental research.

Among universities, geosphere research is significant at the ELTE Faculty of Science and ME Faculty of Earth Science and Engineering, but BME Faculty of Civil Engineering and Óbuda University Alba Regia Technical Faculty should also be noticed. The major infrastructures of public geological research are owned by the Hungarian Mining and Geological Service (MBFSZ) and the Department of Remote Sensing and Land Administration of Budapest Metropolitan Government Office.

NATURAL RESOURCES: Modern society is increasingly dependent on mineral and energy resources. The basic infrastructure of MBFSZ: the core sample base and the mineral resources databases are dominant in this field. From universities, the ME Centre of Excellence in Sustainable Natural Resource Management (the geology testing laboratory, the geology database development and management laboratory, the fluid mining educational and research laboratory, and the educational, research and innovation centre for technology, geoscience and environmental science) is notable.

CLIMATE CHANGE: Biosphere-lithosphere interactions (e.g. soil-stored organic carbon as one of the most significant easily mobilising elements of the exogenous biogeochemical carbon cycle), quaternary and surface evolution, paleoclimatology, recent climate change and natural phenomena related to its potential causes (e.g. solar wind-magnetosphere energy coupling) are the main areas of research. Two global geophysical station chains have been created on a Hungarian initiative to investigate the field around the Earth: one is measuring the Earth's ionospheric cavity resonator (the so-called Schumann resonance) and the other one the changes in the planet's plasma environment as a function of space and time.

ENVIRONMENTAL PROTECTION: In addition to the listed research sites, a multitude of SMEs have substantial infrastructures in the field of geosphere-environmental protection.

National coordinator of the RI group:
MTA Research Centre for Astronomy and Earth Sciences

Contact: László Szarka
Email: Szarka.Laszlo@csfk.mta.hu
Website: http://csfk.mta.hu/

Partners: MTA CSFK GGI; MTA CSFK FGI; MTA CSFK FTI; MTA CSFK CSI; MTA Atomki; MTA Wigner FK; MTA-ELTE Geological, Geophysical and Space Sciences Research Group; MTA-MTM-ELTE Paleontological Research Group; MTA-ELTE Volcanology Research Group; MTA-ME Technical Geoscience Research Group; MTA-PE Air Chemistry Research Group; PTE; Hungarian Mining and Geological Service; Budapest Metropolitan Government Office, Department of Remote Sensing and Land Administration

ESFRI connection: EPOS

Status of the RI group: under implementation

Background information

EPOS (European Plate Observing System) is an ESFRI ENVIRONMENT geosphere research initiative aimed at building a continental-scale earth observation system. Out of the 10 EPOS thematic cores, the EPOS Hungary consortium, which was established in 2015 and led by MTA CSFK, primarily focuses on seismology, GNSS observations, volcanism, satellite radar interferometry and magnetic observatories, based on the existing infrastructures. The background infrastructure is provided by the national seismological network operated by MTA CSFK GGI Kövesligethy Radó Seismological Observatory, the István Széchenyi Geophysical Observatory, the Sopronbánfalva Geodynamics Observatory and the geophysical observatories and national geophysical (field) databases of the active GNSS network belonging to Budapest Metropolitan Government Office. Hungarian institutions and research teams are also involved in other EPOS themes (monitoring of active fault lines, human activity risks, geological data systems, analogue modelling laboratories, geothermics).

Aim of the RI group

The infrastructure group aims to ensure the infrastructural conditions of multifaceted research: on the one hand, by combining the shared environmental infrastructures of domestic partners (observatories, measurement networks) and strengthening cooperation between partners, and on the other hand, by involving laboratories established for non-environmental purposes. Particular attention should be paid to the countryside-Budapest relation (e.g. use of research infrastructures developed in the countryside by researchers in Budapest). EPOS requires administrative engagement on the basis of domestic professional competence and international justification.researchers in Budapest). EPOS requires administrative engagement on the basis of domestic professional competence and international justification.

7.2. ENVIRONMENT

BIOSPHERE, ECOLOGY AND AGRICULTURAL RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group

The ecology and biodiversity research network is primarily concerned with the functioning of ecosystems and the role of biodiversity. The biodiversity and ecosystem research infrastructure builds on existing knowledge, which can be effectively utilised by the internationalisation and further development of databases and knowledge systems. This is why national commitment and cooperation with ESFRI is necessary and important: the goal corresponds to the objectives of the Life Watch RI as well as that of the future eLTER RI which will focus on long-term research. DANUBIUS-RI brings together and develops research infrastructures dealing with European river–sea systems and establises new research centres. The DANUBIUS-RI physically comprises one HUB (research centre in Romania), nodes (analytical, modelling and monitoring centres which may involve several institutions across borders) and super sites (physical research areas focusing on the better understanding of specific phenomena; Hungary has suggested such a site in the Szigetköz area). Hungary expects that all members of the network will have access to all shared DANUBIUS-RI resources (infrastructure outside the country, intellectual property, research capacity, data etc.).

Agricultural activities are closely linked to environmental and ecological issues. Sustainability, biodiversity, climate adaptation and food security are central issues to agricultural research. Several analytical and biological research tools can be used for different purposes (subject to a special sample preparation method). As long as these general tools are relatively easily accessible, field infrastructure (arable land, barn, monitoring, gene pool, country-wide soil monitoring database) will be highly appreciated globally due to its time-consuming and cost-intensive nature and uniqueness. For the time being, Hungary has a major competitive advantage in this area.

National coordinator of the RI group:
HAS Centre for Ecological Research, University of Debrecen
Contact: András Báldi
Email: baldi.andras@okologia.mta.hu
Website: http://okologia.mta.hu/

Partners:
LifeWatch: MTA ÖK; NAIK; MME; Ministry of Rural Development; DE TTK; SZTE, SE; MTA ÖK; Directorate of the Őrség National Park.
Danubius: SZE; MTA ÖK; ELTE TTK Institute of Geography and Earth Sciences; MTA CSFK

ESFRI connection: DANUBIUS-RI; pre-implementation stage (mapping of potential connections with the LifeWatch ERIC; assessment of potential Hungarian participation in eLTER which is currently competing for being included in the ESFRI Roadmap.)

Status of the RI group: operating network

Background information
MTA ÖK is the coordinator and engine of the RI. In 2015, it established the Ecological Biodiversity Network with nine partners to support LifeWatch (http://www.lifewatch.eu/). They participate in a number of international projects and programmes, such as the EU projects Openness, BioVel, Esmeralda and EcoKarst, and contribute to the work of the IPBES intergovernmental platform. DANUBIUS has 29 international and 4 Hungarian partners (http://www.danubius-ri.eu/). However, only SZE is a contracted partner of the international consortium.

Aim of the RI group
The most important task is to formally join the infrastructures. Therefore, a decision must be made on joining the LifeWatch ERIC, and Hungary should take part in the preparatory work of eLTER which is expected to be included in the ESFRI Roadmap. Focus should be on participation in database development and data processing tasks and in joint research programmes. An important aim of the further development of the RI group is to strengthen the researcher potential in the entire RI group to ensure that the domestic research communities (e.g. MTA ÖK EcoInfLab) have access to a wide range of international research data and databases. The long-term ecological field research network operated by the RI is one of the oldest in Europe, with major achievements both in experimental ecological research and in socio-ecological interdisciplinary topics.

7.3. Health and Food Sciences

Health and food sciences research covers a wide range of topics generally aimed at preserving and improving people's health and supplying them with safe food.

This field of science has witnessed a significant paradigm shift in recent decades. Theoretical research has been increasingly taking advantage of the latest technological developments of data collection and analysis, and has been more and more characterised by a systems approach and network research. The structuring and analysis of big data made it necessary to create specialised databanks and analytical systems, and to develop biological model systems. The volume of data in life sciences increases exponentially, so its storage, accessibility, secure use and efficient retrieval represent a growing challenge for bioinformatics researchers.

Exploitation of basic research output has significantly speeded up, in many cases owing to the advanced technological background. Research in this field ranges from the better understanding of diseases, early diagnosis and prevention to effective treatments, therapies and personalised medicine.

In line with these trends, Hungarian biomedical research has gone through major developments in recent years, resulting in the integration of services, technologies, resources and knowledge, and in a new, more advanced and more efficient research infrastructure network that is better integrated into the European Research Area. In addition to biobanks, animal core facilities, clinical research and imaging, bioinformatics and structural biology, this chapter presents the latest developments in agriculture and food science, and their connections with European research infrastructures.

Figure 3: Brain surgery operation assisted by a surgery robot installed in an R&D project within the National Brain Research Program

7.3. HEALTH AND FOOD SCIENCES

BIOBANKS AND ANIMAL CORE FACILITIES RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group

Hungarian biobank networks have altogether 35 registered members, all licensed by the State Public Health and Medical Officer Service. Two universities' biobank networks have adopted an operational policy approved by the Senate. One biobank network is a member of the BBMRI ERIC. Currently, in the framework of projects co-funded by the Structural Funds, several research groups and RIs are being established to join the Biobanks and animal core facilities RI group.

Biobanks provide services for basic and applied research at universities, and statistics for feasibility tests in the preparation of clinical trials related to rare diseases. Biobanks with genomics databases support ongoing research projects by identifying population-specific genetic variants. The data structures of individual biobanks are extremely varied which prevents interoperability between biobank networks.

Nationally, 7 animal core facilities have been identified within the Life Sciences Working Group. These include central animal core facilities at 5 universities and animal testing activities at 2 universities coordinated by 3 large animal core facilities.

National coordinator of the RI group:
Semmelweis University

Contact: Mária Judit Molnár
Email: molnar.mariajudit@med.semmelweis-univ.hu
Website: http://semmelweis.hu/genomikai-medicina/

Partners:
Biobanks: DE Biobank Network (4 members); PTE Biobank Network; SE Biobank Network (15 members); SZTE Biobank Network (15 members)
Animal core facilities: DE Animal Core Facility; ELTE Central Animal Core Facility; MTA KOKI Central Animal Core Facility; MTA SZBK Central Animal Core Facility; PTE Central Animal Core Facility; SE; SZTE Central Animal Core Facility

ESFRI connection: ELIXIR; BBMRI-ERIC; ECRIN-ERIC

Status of the RI group: under implementation

Background information
The number of members and the central regulation of operation vary by university biobank network. Not all Hungarian biobanks have joined the BBMRI ERIC, and not all of them have a Senate approved operational policy in place. The establishment of the MOLMEDEX Biobank is currently in progress, and it will belong to the Biobanks RI group. Most institutes of the Hungarian Academy of Sciences operate a central animal core facility. DE and SE have grouped animal housing and care tasks into 3-3 core facilities.

Aim of the RI group
One of the main development directions of the RI group is to harmonise biobank activities in Hungary (harmonisation of standard operations and data to be collected) and provide quality assurance for Hungarian biobanks. Another goal is to connect all domestic SRIs with the BBMRI ERIC, and to involve the biobank networks of MOLMEDEX members in MOLMEDEX research projects. As a long-term objective, biobank databases should be made compatible with each other. This primarily requires digital technology developments, which in turn would also make it possible to increase the openness with a uniform nationally visible biobank database. The storage and visibility of genomic research data in a national database would strongly support domestic genomics research.

7.3. HEALTH AND FOOD SCIENCES

CLINICAL MEDICINE RESEARCH INFRASTRUCTURE GROUP, ECRIN-ERIC NETWORK

Presentation of the RI group

The European Clinical Research Infrastructure Network (ECRIN ERIC) is a nonprofit organisation classified as "landmark" in the ESFRI Roadmap, which aims to support scientific, multi-centre drug development research with no commercial intent in Europe. Through the HECRIN Consortium, Hungary became a full-fledged member in the ECRIN-ERIC in 2014. The HECRIN Consortium supports the internationalisation of clinical research initiated by Hungarian researchers and involves Hungary in the clinical research projects of other European countries. The results of human clinical trials have a significant impact on the development of clinical medicine.

National coordinator of the RI group:
University of Pécs, Szentágothai Research Institute

Contact: Gábor L. Kovács
Email: kovacs.l.gabor@pte.hu
Website: http://szkk.pte.hu/
ECRIN contact point: Dr. Zita Tarjányi
Email: tarjanyi.zita@pte.hu

Partners: PTE Clinical Centre – multiple examination locations; UP Human Clinical Examination Registration Centre; DE Clinical Centre – multiple examination locations; DE Coordination Centre for Drug Development; SE Clinical Centre – multiple examination locations; SE Clinical Centre, Registration Office; SZTE Clinical Centre – multiple examination locations; SZTE Clinical Centre, Clinical Research Coordination Office; National Institute of Oncology; National Institute of Rheumatology and Physiotherapy; National Institute of Clinical Neurosciences; National Korányi Institute for Pulmonology; Gottsegen György Hungarian Institute of Cardiology; State Hospital for Cardiology, Balatonfüred; Heim Pál Children's Hospital; MCRN Hungary (Medicines for Children Research Network); MTA TTK Brain Imaging Centre

ESFRI connection: ECRIN-ERIC

Status of the RI group: under implementation

Background information

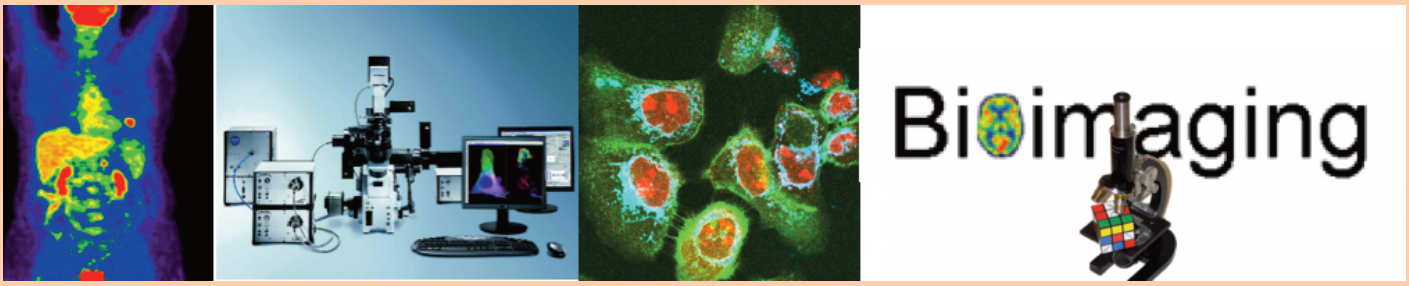
The HECRIN Consortium operates as a distributed research infrastructure. It represents 125 university clinics and diagnostic institutes, as well as 100 hospital units, and – apart from county hospitals to be joining later – covers the entire Hungarian research network capable of innovative clinical research. In 2017, the NRDI Office has officially announced Hungary's participation in the ECRIN ERIC infrastructure. Hungary is represented by the NRDI Office, the HECRIN Consortium works as the Hungarian science centre, and the leader is the University of Pécs (based on the decision of HECRIN Consortium members, and the approval of the State Secretariat for Health of the Ministry of Human Capacities and the NRDI Office). The HECRIN Consortium is professionally coordinated by Dr. Gábor L. Kovács (PTE), member of the Hungarian Academy of Sciences.

Aim of the RI group

Clinical trials are usually financed by European or national research funds or non-profit organisations. The HECRIN Consortium received government subsidy (GINOP-2.3.3-15; EFOP 3.6.2-16-2017-00009) for the development of the integrated, harmonised clinical trial network at the trial sites of the four Hungarian universities. The goal is to accentuate Hungary's capabilities in innovative, high-quality clinical research, including studies on medicines, clinical nutrition science, pharmaceutical drugs and medical devices. The Consortium supports the strengthening of the research potential and its translation into practice through accredited processes, promotes continuous professional training, and makes efforts to exploit the wealth of clinical data in research.

7.3. HEALTH AND FOOD SCIENCES

BIOIMAGING RESEARCH INFRASTRUCTURE GROUP
EURO-BIOIMAGING CONSORTIUM



Presentation of the RI group

Advanced Light Microscopy and medical imaging play an increasingly important role in biomedical basic and applied research and in diagnostics, which is clearly confirmed by the two recent Nobel Prizes in this field (2014: super-resolved fluorescence microscopy, 2017: cryo-electron microscopy). Under the governance of European light microscopy and medical imaging microscopy laboratories, the Euro-BioImaging (EuBI) ESFRI consortium was formed in December 2010 (www.eurobioimaging.eu) and will operate as an ERIC. The aim of the consortium is to connect European microscopy and medical imaging service provider laboratories into a network. The Hungarian BioImaging Network was established in 2009 with 26 members. Several members of the network (University of Debrecen, Semmelweis University, HAS Biological Research Centre, Femtonics Ltd.) have partnered in a joint EuBI Node project proposal.

The non-exhaustive list of technologies available in the infrastructures: super-resolution systems capable of single-molecule detection and approximation (stimulated emission depletion, STED, two-photon STED; photoactivated localization microscopy, PALM; stochastic optical reconstruction microscopy, STORM; structured illumination microscopy, SIM), optical tweezers, in vivo functional microscopy (e.g. multiphoton microscopy, 2D and 3D, fast two and three-photon scanning laser microscopy; Förster resonance energy transfer, FRET-microscopy; fluorescence lifetime imaging microscopy, FLIM, rescueSTED-FLIM; fluorescence [cross]correlation spectroscopy, F[C]CS; differential polarization laser scanning microscopy, DP-LSM; Rescan Confocal Microscopy [RCM] with polarization imaging attachment; total internal reflection fluorescence, TIRF), stimulated Raman spectroscopy (SRS), high throughput microscopy, machine learning algorithms, automated image analysis, laser dissection and analysis of unique cells, functional medical imaging equipment (e.g. CT, PET/CT, MRI, SPECT, fMRI, NEXSTIM), pet imaging equipment for preclinical, translational research (e.g. mini-PET, nano-PET/CT, PET/MRI, fMRI, micro-CT, bioluminescence imager). Application areas of the infrastructure in biological and biomedical basic and applied research: brain research, development of surgical diagnostic and therapeutic devices, drug design, nano-biotechnology, structural biology, membrane biology, cell biology, developmental biology, bioinspired smart materials. Group members engage in methodology and device development and manufacturing. The partners are cooperating in a number of running projects. The infrastructures are also available for domestic and foreign researchers.and foreign researchers.rs.

National coordinator of the RI group:
University of Debrecen

Contact: György Vámosi
Email: vamosig@med.unideb.hu
Website: http://biophys.med.unideb.hu/en/Molecular%20Cell%20Analysis%20Core%20Facility
http://bioimaging.unideb.hu/List_of_Facilities

Partners: University of Debrecen - multiple locations; HAS Biological Research Centre - multiple locations; University of Pécs - Szentágothai Research Centre; UP Medical School, Clinical Centre; Semmelweis University – multiple locations; University of Kaposvár; HAS Institute for Nuclear Research; HAS Institute of Experimental Medicine; Femtonics Ltd.; Eötvös Loránd University; HAS Research Centre for Natural Sciences; University of Szeged

ESFRI connection: Euro-BioImaging
Status of the RI group: under implementation

Background information

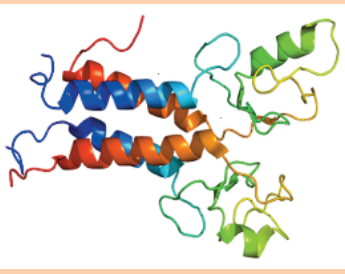
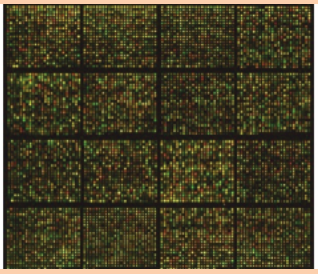
The Hungarian BioImaging Network operates as a distributed research infrastructure. The diversity of the methods requires specialisation. 26 university and research institution laboratories form part of the network, and several other labs have indicated their intention to join. The partners have world-class instrument parks, developed in a coordinated manner from GINOP instrument development funding. The members of the network have partnered in several joint GINOP project proposals in which BioImaging plays a decisive role. Several members of the network participated in a joint Euro-Bioimaging Node project proposal in 2014, which was endorsed by the professional jury and ratified by the EuBI Interim Board.

Aim of the RI group

The current goal is to make the Euro-Bioimaging Node operational, which will satisfy the needs of domestic and European researchers, connecting them to the global research community. Due to the rapid development of imaging technology, there is a continuous demand for developing the infrastructures. This development activity is largely carried out by the members of the RI group.

7.3. HEALTH AND FOOD SCIENCES

BIOINFORMATICS RESEARCH INFRASTRUCTURE GROUP, ELIXIR NETWORK, ELIXIR CONSORTIUM OF HUNGARY (ELIXIR-HU)

Presentation of the RI group

Bioinformatics research in Hungary can be grouped around five main themes: human genomics (medical genomics and cell biology), agrigenomics, proteomics, veterinary sciences (virology) and ecology (biological networks) . Although members of the RI group work in different research areas, what they have in common is the integrated handling, processing and interpretation of large amounts of data originating from biological measurements.

The RI's assets enable complex studies of clinical genomics, and the results of these studies can be used in research, medicine and education. The most cited online softwares deal with protein structure prediction, prediction of transmembrane protein topology and evaluation of the prognostic value of oncology biomarkers.

Databases also constitute integral parts of the RI, for example the Hungarian Oncogenome Portal (human genomics), the database of adenovirus sequences (virology), the UniTMP databases (proteomics) and the MÉTA website (ecology). The RI group is also committed to the expansion of bioinformatics training services.

National coordinator of the RI group:
MTA Research Centre for Natural Sciences, Institute of Enzymology (MTA TTK EI)

Contact: László Patthy
Email: patthy.laszlo@ttk.mta.hu
Website: http://www.ttk.mta.hu/

Partners:
Eötvös Loránd University (ELTE), University of Debrecen (DE), Semmelweis University (SE), Szentágothai Research Centre, University of Pécs (PTE); University of Veterinary Medicine (ÁTE), Pázmány Péter Catholic University (PPKE), National Institute of Oncology (OOI), National Agricultural Research and Innovation Centre (NAIK), MTA Centre for Ecological Research (MTA ÖK), MTA Alfréd Rényi Institute of Mathematics (MTA RAMKI), Institute for Veterinary Medical Research, MTA Centre for Agricultural Research, (MTA ATK ÁOTI)

ESFRI connection: ELIXIR

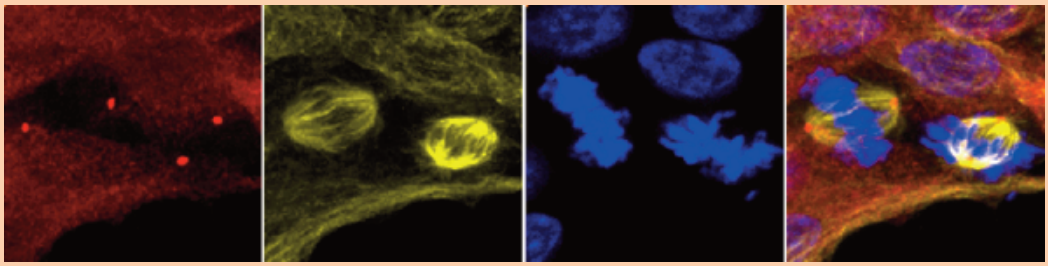
Status of the RI group: under implementation

Background information
The national coordinator of the RI group (and of the Hungarian ELIXIR Node to be implemented) is the Institute of Enzymology of MTA TTK. The RI group consists of intensely cooperating Hungarian universities and research institutions that play a leading role in life sciences in Hungary. Members of the RI group participate in major international research programmes such as the Joint Action on Rare Cancers, COMPARE, ECRIN, EMBnet and eLTER RI. The portfolio of equipments (next-generation sequencing systems, high performance computing infrastructure) has been renewed by major investments and continuous progress in software and database development is a hallmark of the development of the RI.

Aim of the RI group
The aim of the RI group is to promote the application and advance of bioinformatics in all areas of life sciences in Hungary. It strives to join international programmes as a full-fledged member of ELIXIR and to provide Hungarian bioinformatics services to the international scientific community. The ELIXIR membership is expected to boost international research cooperation and this will require further significant investments in the bioinformatics RI.

7.3. HEALTH AND FOOD SCIENCES

BIOMOLECULAR INTERACTIONS, STRUCTURAL BIOLOGY AND MOLECULAR IMAGING RESEARCH INFRASTRUCTURE GROUP



Presentation of the RI group

The analysis of life phenomena at the molecular level is an essential part of modern life sciences and biomedical research. To be internationally competitive in the latter area we need to organise a domestic infrastructure group which can use the results of atomic structural biochemistry, which have a fundamentally physical nature, to understand how macromolecular complexes function within the cell. Discovery research offer enormous benefits for this area, which is most obviously manifested in drug development for society (EU-OPENSCREEN; http://www.eu-openscreen.eu). The study of biomolecular interactions can be interpreted in three interrelated areas: 1) structural biochemistry, which seeks to reveal atomic structures (INSTRUCT; https://www.structuralbiology.eu); 2) classical biochemistry, which characterises the physical nature of interactions, and 3) microscopy techniques suitable for the examination of intracellular molecular interactions usually by using imaging procedures (EURO-Bioimaging; http://www.eurobioimaging.eu) Such a massively complex infrastructure demanding extensive expertise (in physics, chemistry and biology) could be most effectively operated in a distributed arrangement, which builds on expertise and capacities that already exist or are under development (through project proposals co-financed from the Structural Funds).

National coordinator of the RI group:
Research Centre for Natural Sciences, Hungarian Academy of Sciences

Contact: Attila Reményi
Email: remenyi.attila@ttk.mta.hu
Website: http://ttk.mta.hu/

Partners: DE; PTE; SZTE; SE; BME; ELTE; MTA SZBK; MTA KOKI

ESFRI connection: EU-OPENSCREEN; Euro-BioImaging; INSTRUCT

Status of the RI group: under implementation

Background information
The three related ESFRI projects classified under the Health & Food development area also involve Hungarian researchers who are represented by coordinators (EU-OPENSCREEN – MTA TTK; EURO-Bioimaging – DE; INSTRUCT – BME, ELTE). All three projects are geographically distributed, and the users use the capacities of specialised service centres for the implementation of their specific project plans.

Aim of the RI group
Domestic infrastructures suitable for the examination of biomolecular interactions should be aligned with projects included in the ESFRI Roadmap . By providing measurement functionalities, the capacities of the domestic RI group will facilitate the dispatch of Hungarian initiated projects to larger-capacity international consortium centres. This is important because ESFRI accredited centres can only be used cost-effectively in possession of preliminary results which increases the success of the project in larger-capacity centres abroad.

7.3. HEALTH AND FOOD SCIENCES

AGRICULTURAL AND FOOD RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group

Modern agricultural and food science research is essential to ensure sufficient, healthy and nutrition-rich food supplies. Agriculture is responsible for the production of food ingredients in such a way to avoid food contamination and environmental pollution. Hungary has achieved outstanding results in the past and has excellent features to perform these tasks. However, to stay internationally competitive in research it is necessary to organise the functioning of a national infrastructure group that can use the output of basic research (in physiology, genetics, genomics, molecular biology etc.) and translate it to applied research (plant breeding, production technology, precision agriculture, food industry etc.) to produce safe and competitive end-products. Discovery research in this area can help mitigate the adverse impact of anticipated climate change on agricultural production, develop biological resources able to adapt to changing environmental conditions, and produce functional food ingredients. The infrastructures currently possessed by the group members are only partially suitable for securing the conditions for internationally competitive research. Therefore, they not only need to be developed but they should also be shared between members in a coordinated way, while further broadening cooperation already featured in many projects.

National coordinator of the RI group:
HAS Centre for Agricultural Research

Contact: Ottó Veisz
Email: veisz.otto@agrar.mta.hu
Website: www.agrar.mta.hu

Partners: NAIK – multiple research institutes; PE Georgikon Faculty; DE Faculty of Agricultural and Food Sciences and Environmental Management; SZIE Faculty of Food Science; SZE Faculty of Agricultural and Food Sciences, KE Faculty of Agricultural and Environmental Sciences

ESFRI connection: None

Status of the RI group: under implementation

Background information

The group comprises 9 organisational units and experimental systems of MTA ATK institutes, several research institutions of the National Agricultural Research and Innovation Centre operating under the aegis of the Ministry of Agriculture, and several faculties and related research institutes of the four agricultural universities. Based on the 2014 certification of the infrastructures by the NEKIFUT project, it is reasonable to create the group from the strategic research infrastructures established by the above-mentioned organisations (e.g. MTA ATK Experimental crop production system, Experimental soil quality and nutrient turnover system, SZIE Food Science RI, Method development for the detection of individual bioactive food components), two network groups (Agricultural Plant Genebank, plant phenotyping infrastructure), and 24 units which received unique research infrastructure status.

Aim of the RI group

The infrastructures operate in different types of institutions across the country, representing different quality standards. The aim is concentrated development. MTA ATK received funding for its project "Creation of a metabolomics platform in support of agricultural research" (GINOP-2.3.3-15-2016-00018). Further significant infrastructure development is needed, which is expected to be implemented in the next 3 years based on already available plans.

7.4. Physical Sciences and Engineering

Using available cutting-edge large facilities, complex equipment and research infrastructures, Physical Sciences and Engineering (PSE) researchers, on the one hand, perform basic research and enrich scientific knowledge in their own, well-defined fields of science, and on the other hand, apply the analytical methods and data processing techniques developed over years to achieve R&D results which can facilitate progress in other scientific fields or in the industry. The development of PSE research infrastructures exhibit this duality: they are strongly interdisciplinary and most of their large facilities (particularly those suitable for materials testing) are heavily used by industrial actors and researchers from other fields. This strong demand greatly influences the design, construction and operation methods of many large facilities.

PSE infrastructures are used to examine an abundance of things: from the smallest elementary particles that make up matter and the formation and current large-scale behaviour of the universe, to the properties of everyday materials, metals, semiconductors, nanosystems and biological samples.

The high-value research equipment established by the joint effort of several countries provide a significant competitive advantage to their users, but to use PSE research infrastructures it is also essential to have a network of local laboratories where the projects are prepared for the large facilities and professionals are trained. All efforts must be made to integrate local laboratories, and small and medium sized national infrastructures into internationally acclaimed, highly significant PSE infrastructures.

The following part of the chapter will summarise how large international facilities that are considered important for PSE research from a Hungarian perspective are connected to smaller national equipment and laboratories; to what extent Hungary managed to catch up and lay the foundations of further development in recent years; and what are Hungary's take-off opportunities and hidden potentials.

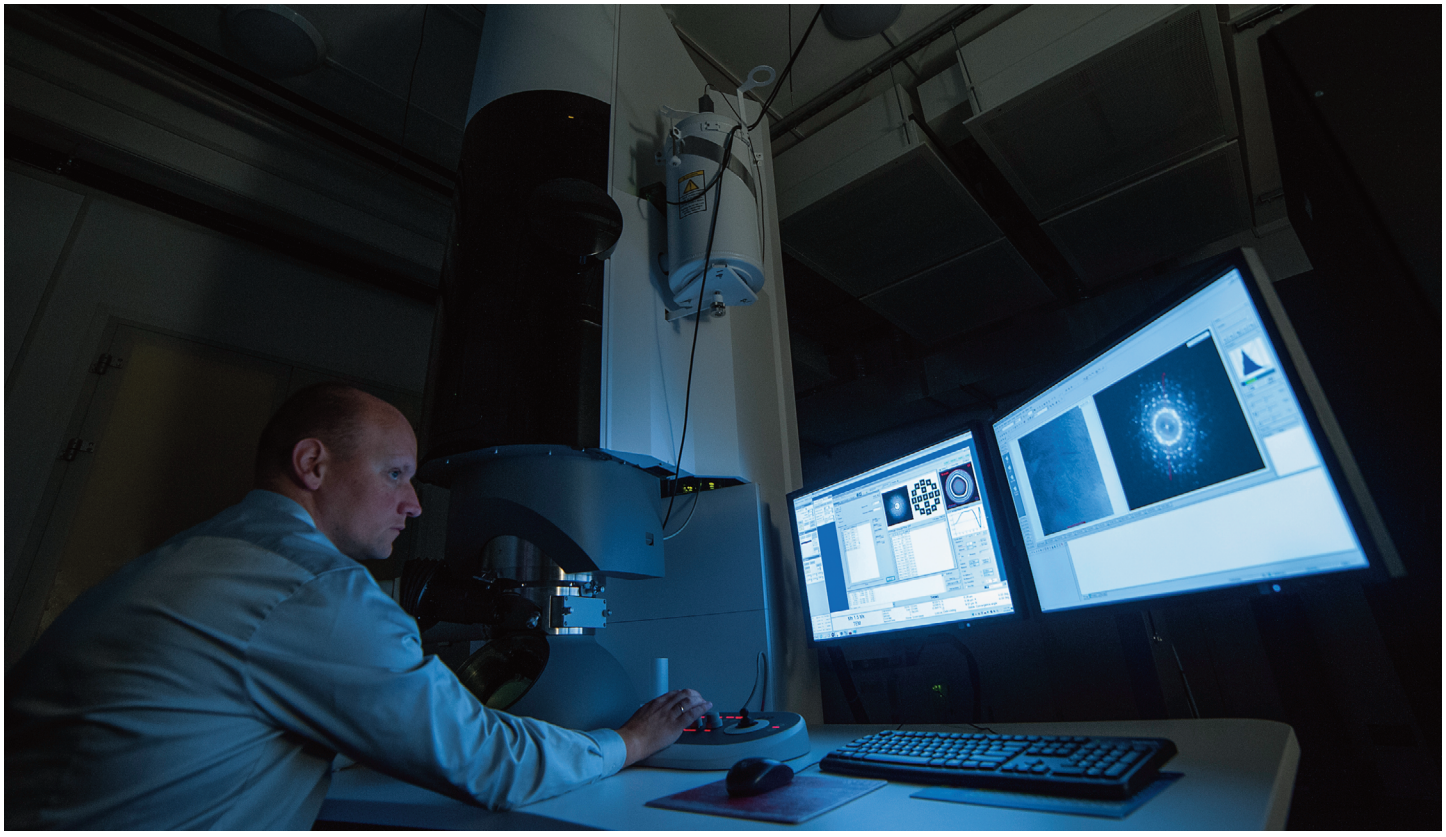
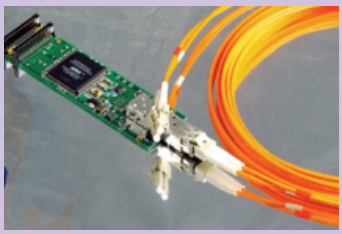
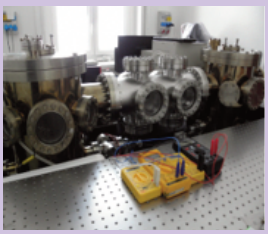


Photo: Szigeti Tamás / MTA

Figure 4: Spherical-aberration-corrected electron microscope at the Wigner Research Centre for Physics of the Hungarian Academy of Sciences

7.4. PHYSICAL SCIENCES AND ENGINEERING

PARTICLE PHYSICS RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group

According to current knowledge, particles exchange energy and momentum in four types of fundamental interaction: strong, weak, electromagnetic and gravitational interaction. Researchers at CERN study the first three. Hungary has been a member of CERN since 1992 with a contribution of 1%. Hungarian physicists and engineers have participated in countless world-class particle physics experiments in the last 25 years. They contributed to the discovery of the Higgs boson (CMS) and the quark-gluon plasma (ALICE). The domestic background was provided by the MTA laboratories where detectors and data collection systems used in the experiments were developedy, as well as the academic and university computer clusters on which data were analysed and the theoretical simulations were run. Domestic laboratories are currently contributing to projects in the High-Luminosity Large Hadron Collider (HL-LHC). To be launched in 2023, the research programme of HL-LHC has been designed until 2035, anticipating high level Hungarian contribution and equipment supervision. In 2016 works have started to design the next accelerator, the Future Circular Collider (FCC), which would be built by 2035. Here Hungarian researchers take part in the design and prototype development of FCC superconducting beam kick-out magnets. They are studying in parallel to produce super-homogenous plasma with high intensity lasers, and examining particle acceleration with plasma waves (AWAKE). They participate in the testing of gravitational interaction and contribute to the discovery of gravitational waves through the European Gravitational Observatory in connection with the VIRGO detector (EGO VIRGO). Presently, a third generation Einstein Telescope is being developed, and the researchers contribute to it in the field of seismography and noise research through measurements made in the Matra Gravity and Geophysical Laboratory and the Jánossy Cosmic Radiation Laboratory located underground in Csillebérc, Budapest. Successful research in particle physics demands a top level IT support. Currently, the Tier-0 unit (4 MW) of Wigner Data Centre, the HAS Cloud and the Wigner Cloud, the Tier-2 cluster and the GPU Laboratory, and the ELTE lattice QCD cluster are supporting research and development activities.

National coordinator of the RI group:
HAS Wigner Research Centre for Physics

Contact: Péter Lévai
E-mail: levai.peter@wigner.mta.hu
Website: https://wigner.mta.hu/; https://wigner.mta.hu/hep

Partners: MTA Wigner FK - Tier 2 cluster; GPU Laboratory; DAQ Laboratory; Momentum Innovative Detector Development Laboratory; Magnetic Acceleration Technology Laboratory; Matra Gravitational and Geophysical Laboratory; Jánossy Cosmic Radiation and Gravity Laboratory; MTA Atomki Laboratory of Electronics and Detector Development; ELTE – HPC cluster performing lattice QCD calculations

ESFRI connection: HL-LHC; PRACE; EGO ERIC; Einstein Telescope (planned application)
Status of the RI group: implemented, operates at international level

Background information

In addition to MTA Wigner FK and MTA Atomki, experimental and theoretical particle physics research is also performed at ELTE and the University of Debrecen. Further contributors are those companies who were involved in the supply chain as CERN tender winners, such as CERNTech, Engious Kft. and MVM. MTA Wigner FK, MTA Atomki, MTA CSFK, ELTE, BME, the University of Miskolc and Eszterházy University take part in gravity research.

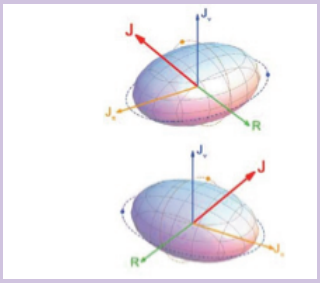
Aim of the RI group

Particle physics research primarily takes place in CERN. The participating institutions take part in the programmes of CERN, with the main focus on HL-LHC developments, carried out in Hungarian laboratories. The preparatory works of the Future Circular Collider are implemented simultaneously, with the focus on the development of superconducting magnets. Improved technological support of gravity research is one of the main tasks for Hungary in the upcoming 2-3 years. This work includes the various noise filtering, noise and heat spreading prevention techniques, the development of seismological monitoring methods, and participation in the selection of sites. These activities prepare participation in the Einstein telescope project (proposed for the 2020 update of the ESFRI Roadmap).

7.4. PHYSICAL SCIENCES AND ENGINEERING

NUCLEAR PHYSICS, ATOMIC PHYSICS AND THEIR APPLICATIONS RESEARCH INFRASTRUCTURE GROUP



Presentation of the RI group

Europe assigns great priority to the development of nuclear physics infrastructures. They are largely based on the particle accelerators and – in a smaller part – on research-purpose fission reactors, or they are experimental fusion equipment. Acceleration technology is not only used by nuclear physics but also by particle physics, atomic and molecular physics (which study high energy processes in the electron shell), as well as many applications in materials science, plasma physics, space physics or cancer therapy. The variety of analytical nuclear materials science methods, that evolved from the toolset of atomic and nuclear physics, is of utmost importance. Apart from basic research, domestic nuclear physics infrastructures also play an important role in applications in the field of materials science, radiation biology, environmental protection and cultural heritage protection. The group consists of a number of laboratories, which carry out their work in close collaboration. Its most outstanding infrastructures with the largest number of assets are the MTA Atomki Accelerator Centre and the BNC Neutron Spectroscopy Laboratory.

National coordinator of the RI group:
HAS Institute for Nuclear Research

Contact: Zsolt Dombrádi
Email: domb@atomki.mta.hu
Website: http://atomki.mta.hu

Partners: MTA Atomki Accelerator Centre; MTA Atomki Laboratory of Nuclear Physics; MTA Atomki Laboratory of Atomic Collisions; MTA Atomki Laboratory of Ion Beam Physics; MTA Atomki Heritage Science Laboratory; MTA Atomki Laboratory of Cyclotron Application; MTA Atomki Laboratory of Electron Spectroscopy and Materials Science; MTA Atomki Tandetron Laboratory; MTA Atomki Laboratory of Theoretical Physics; MTA Wigner FK BNC Neutron Spectroscopy Laboratory; MTA Wigner FK RMI Ion Beam Analytics and Ion Implantation Laboratory; MTA Wigner FK Molecular Beam Epitaxy Laboratory; MTA Wigner FK Mössbauer Spectroscopy Laboratory; MTA Atomki – MTA Wigner FK Hungarian Ion-beam Physics Platform (HIPP)

ESFRI connection: E-RIHS; GSI FAIR; GANIL SPIRAL2; ESS ERIC; CERIC ERIC; ILL 20/20

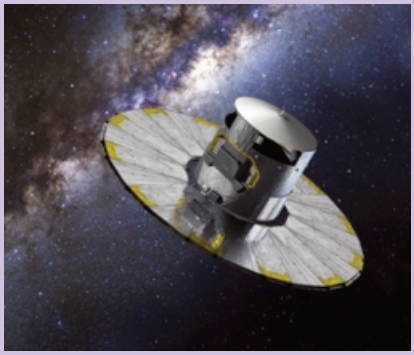
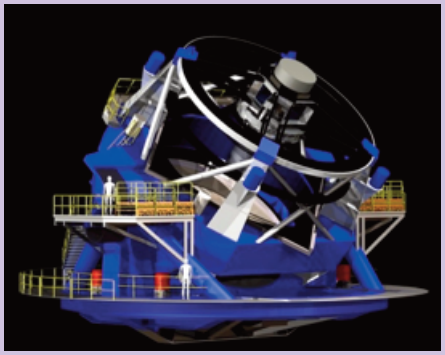
Status of the RI group: partly under implementation

Background information
The group is coordinated by coordinator MTA Atomki where Hungarian experimental nuclear physics research started 70 years ago. Accelerator-based research in nuclear physics and ion beam analytics also dates back to 40 years ago. Most of the partner laboratories operate here, engaging in activities from theoretical and experimental basic research in nuclear physics to the industrial application of cyclotron and research on analytical methods or heritage science. MTA Wigner FK, which comprises the rest of the partners, has an equally broad spectrum of activities, including neutron physics, ion implantation techniques and Mössbauer spectroscopy in addition to the above.

Aim of the RI group
The RI group aims to constantly expand and modernise the activities, and to develop them in the directions set out by external demand and the latest research trends. The two research centres have already established the Hungarian Ion-beam Physics Platform (HIPP), which coordinates part of their activities corresponding to the focus of the present RI group, and they wish to keep up and further intensify cooperation, drawing on even more resources. They are ambitious to actively develop their ESFRI and ERIC type relations together.

7.4. PHYSICAL SCIENCES AND ENGINEERING

ASTRONOMY RESEARCH INFRASTRUCTURE GROUP


Presentation of the RI group

The formation of stars, planets and planetary systems will be a key research question in astrophysics in the next 15-20 years. Astronomy is currently gaining importance everywhere and constantly delivers exciting new discoveries. Understanding the operation of the Sun, and mapping the Solar System and monitoring its changes, are all absolutely relevant to life on Earth, the planet's climate and environment changes, to our immediate environment in general. Through the observation of the extreme conditions of matter in the cosmos, astronomy is linked to a number of areas of physics. Advanced astronomical instrumentations incorporate all the achievements of cutting-edge technology and information science. The Hungarian astronomical infrastructure allows the implementation of dedicated long-term observation programmes, which gain impact through observations unavailable elsewhere. A network is currently being developed in international and national cooperation for the purpose of constantly monitoring the Earth's environment (Cosmic impacts and risks). Shortly, two new robotic telescopes will be available for exploring and monitoring fast, high-energy processes in the universe, which is a significant development even at European level. The highly qualified, internationally acknowledged researchers employed in the partner institutions of the RI group cover a wide spectrum of astronomical research, including the fields of space physics and nuclear physics.

National coordinator of the RI group:
HAS Research Centre for Astronomy and Earth Sciences, Research Centre for Astronomy and Earth Sciences

Contact: László Kiss
Email: kiss@konkoly.hu
Website: http://konkoly.hu

Partners: MTA CSFK Konkoly Observatory; ELTE Department of Astronomy; ELTE Gothard Astrophysical Observatory; SZTE Institute of Physics; SZTE Baja Observatory; ELTE TTK Institute of Physics; MTA Wigner FK RMI; MTA Atomki

ESFRI connection: OPTICON; AHEAD; EST; ASTERICS

Status of the RI group: partly under implementation

Background information

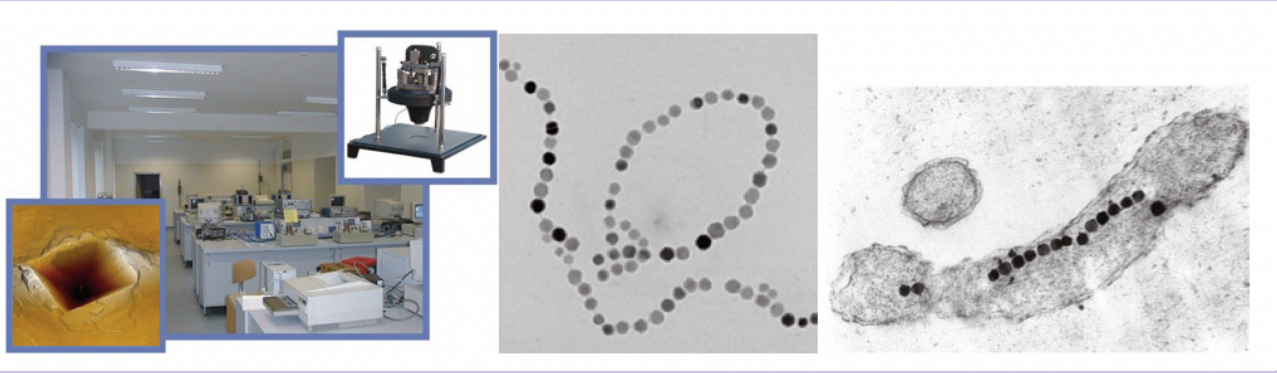
The group coordinator is MTA CSFK Konkoly Observatory (MTA CSFK CSI), which has been the centre of Hungarian astronomical research for 120 years. Both CSI and its researchers have long maintained informal, and sometimes also formal, relationship with most of the listed partners. CSI researchers take part in ongoing and planned European (ESA) space projects (CHEOPS, PLATO, ARIEL), both as users and as coordinators. The domestic research infrastructure is undergoing significant development, and has the ability to achieve world-class results with well-chosen programs. In addition to the listed institutions, there are no other institutions in Hungary that would deal with astronomical research. The requirements set by detection technology are enhancing high-tech and IT development without being exposed to the pressure and risks of market competition.

Aim of the RI group

The aim of the group is to continue their research. They would like to complete the modernisation of the entire national astronomy infrastructure over the next three years. Hungary has been a full-fledged member of the European Space Agency for three years. The group's goal is to intensify cooperation with European space programmes and join the European Southern Observatory (ESO).

7.4. PHYSICAL SCIENCES AND ENGINEERING

MATERIALS SCIENCE RESEARCH INFRASTRUCTURE GROUP



Presentation of the RI group

Materials that are important for modern technologies greatly vary, ranging from metals to semiconductors and organic materials. The mission of materials science is to explore their properties. The laboratories involved in the consortium focus on research on a number of materials belonging to the above-mentioned families, that are also essential for industrial applications. The methods involved in the research of the RI group are: device test methods; X-ray diffraction (ELTE TTK, EK MFA), atomic force microscopy, electron microscopy (EK MFA, ELTE TTK, ME), techniques for determining magnetic properties, Foner magnetometer, Mössbauer spectroscopy, SQUID (Wigner FK), vibration magnetometer (DE), methods for measuring thermal properties, e.g. differential scanning calorimetry (DSC) (DE, ELTE TTK, Wigner FK). These methods are complemented by mass spectrometry suitable for examining atomic composition (DE, BME), X-ray photoelectron spectroscopy suitable for the examination of electron structure characteristics (DE, BME), Auger electron spectroscopy (BME), and the testing of mechanical properties through hardness tests, tensile tests (ELTE), and the measurement of impact energy (DE). Many of the methods listed above allow to perform tests in a special sample environment like low and high temperature, or high pressure. The laboratories also prepare a wide range of samples. The methods applied here include: magnetron sputtering (DE), electron beam evaporation, heat treatment furnaces, ball mills (DE, Wigner FK), focused ion-beam machining (DE, MFA, ELTE). In addition to the traditional macroscopic samples, the participating laboratories increasingly focus on examining nanostructures playing an increasingly important role today.

National coordinator of the RI group:
ELTE

Contact: István Groma
Email: groma@metal.elte.hu
Website: http://wigner.hu/

Partners: DE; MTA EK MFA; MTA Wigner FK; ME; BME; Bay Zoltán Nonprofit Ltd.

ESFRI connection: ESRF; ELI

Status of the RI group: under implementation

Background information

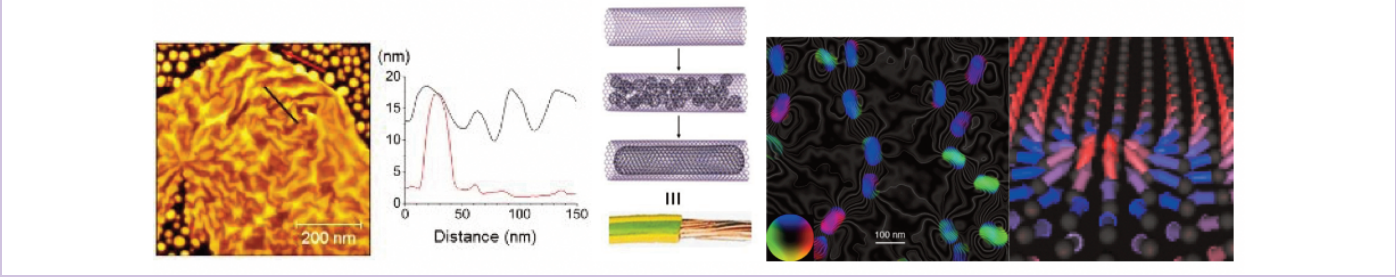
The working group is coordinated by István Groma, head of the Department of Materials Physics at ELTE. Cooperation between the partners is manifested in engaging in common themes, coordinating the educational programs of the participating universities, and the joint participation in the PhD training of research institutions and universities. All members of the working group take part in several foreign research programs. This is supported by the existing high-quality domestic research infrastructure.

Aim of the RI group

In the upcoming period, the infrastructure group will primarily focus on the research of technologically interesting nanostructures. Infrastructure improvements from the currently available funds are also aligned with this goal. The individual research units have a wide range of international contacts. The tasks for the near future is to maintain them and open up towards the ELI ALPS. In addition to the scientific cooperation, the infrastructure group intends to place greater emphasis on collaborating with industrial partners.

7.4. PHYSICAL SCIENCES AND ENGINEERING

SOLID-STATE PHYSICS RESEARCH INFRASTRUCTURE GROUP



Presentation of the RI group

The knowledge and theoretical description of the atomic structure, optical, transport and magnetic properties of materials are essential both for our fundamental scientific understanding and for modern technologies. The experimental and theoretical examination of these properties is the task of solid-state physics. The laboratories of the consortium produce and investigate materials that are currently the most interesting for exploratory research. Atomic structures are determined with modern X-ray diffractometers (MTA Wigner FK, MTA EK MFA) and scanning methods, such as atomic force, tunneling and electron microscopy, as well as transmission electron microscopy and electron holography (MTA EK MFA, MTA Wigner FK, BME, PE). In addition to the traditional methods, some laboratories are developing new measurement techniques, such as X-ray holography or single molecule mapping based on modern free-electron X-ray sources (MTA Wigner FK). In addition to structure characterization, the infrastructure enables the determination of transport and magnetic properties in a wide temperature range and the performance of quantum transport experiments at ultralow (4mK >) temperatures (BME). These investigations are supported by a variety of resonance methods, such as electron spin resonance (ESR, BME), nuclear magnetic resonance (NMR, BME), or optically detected magnetic resonance (ODMR, BME). Optical parameters can be examined with vibrational spectroscopy (infrared and Raman spectroscopy; MTA Wigner FK) and magneto-optical experiments from THz to UV (BME). The properties of electron structure are examined with X-ray spectroscopy (MTA Wigner FK) in the laboratories. In addition to the determination of material properties, it is also very important that research groups have the opportunity to produce samples at their own initiative. To this end, each laboratory is specialiing in different material synthesis techniques. So, there is a synthetic chemistry laboratory specialising in the production of small-molecule organic and inorganic compounds (MTA Wigner FC), and laboratories specialising in the production of thin films (MTA Wigner FK, MTA EK MFA, BME). These allow the production of a variety of materials and structures from high-temperature superconductors, fullerenes and carbon nanotubes to graphene, metal-organic framework (MOF) structures and other nanostructures and nanoelectronic circuits. Materials that cannot be produced in domestic laboratories can be studied in the framework of joint collaborative projects with foreign partners. In addition to experimental equipment, the computational background plays an increasingly important role. It is essential both for the evaluation of measurements and for the theoretical prediction of material properties. Depending on the given task, the laboratories use central large computing systems (e.g. Wigner Cloud) or local computer capacity supervised by them (MTA Wigner FK, SZFI, BME).

National coordinator of the RI group:
HAS Centre for Energy Research, Institute of Technical Physics and Materials Science

Contact: Levente Tapasztó
Email: tapaszto.levente@energia.mta.hu
Website: http://www.mfa.kfki.hu/hu/
Partners: MTA Wigner FK; BME; PE

ESFRI connection: ESRF; EU-XFEL, ELI

Status of the RI group: operating

Background information

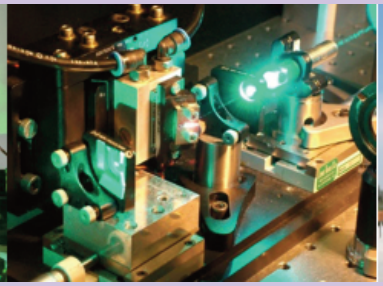
The working group is led by Levente Tapasztó, head of the MTA Energy Research Centre "2D Nanoelectronics" Momentum Research Group. Cooperation between the partners is manifested in engaging in common research projects, coordinating the educational programmes of the participating universities, and the joint participation of research institutions and universities in the PhD training. All members of the working group take part in several foreign research programmes. This is supported by the largely modernised infrastructure of the institutions.

Aim of the RI group

The most important tasks for the upcoming period include the further development of the research infrastructure, the maintenance and further development of the high-level of human resources, preparation for using the large domestic and international infrastructures under construction, and enhancing the capacity of utilisation of existing RIs.

7.4. PHYSICAL SCIENCES AND ENGINEERING

LASER-BASED RESEARCH INFRASTRUCTURE GROUP


Presentation of the RI group
Laser-based research has gained considerable importance by now. This is due to the versatility of laser technology, enabling a variety of uses ranging from industrial machining to telecommunications and medical diagnostics and therapy. Rapidly evolving laser systems with advanced features and beam parameters play an important role in basic research, as well. Lasers capable of delivering ultra-short powerful pulses make it possible to investigate, on the one hand, extremely fast processes taking place in various medi and, on the other hand, due to their increased intensity, new forms of light-matter interactions. The research units of this RI group employ various lasers, laser-based secondary radiation sources (THz, harmonics, extreme ultraviolet etc.) and related measurement technology. Extremely high intensity (ELI-HU, SZTE) and ultra-short pulse lasers (MTA Wigner FK, SZTE) and their secondary sources (PTE, MTA Wigner FK, ELI-HU), as well as the diagnostic, electron spectroscopy instruments which enable the examination of high-intensity interactions (MTA Atomki) are all available. Some laboratories are also capable of growing single crystals for lasers (MTA Wigner FK), while others develop measurement technology for lasers (Bay Zoltan Ltd.). In terms of various laser applications, nano-optical research using short laser pulses (MTA Wigner FK) are important, as they will enable the further development of different spectroscopic methods and optical sensors. Such research can pave the way towards ultra-high-speed data processing. The only laser cooling laboratory in Hungary is currently under construction (MTA Wigner FK) and will make it possible to study special quantum effects. In addition to basic research, laboratories specialising in the industrial, medical and measurement technology applications of lasers also perform successfully (e.g. BME Department of Atomic Physics). These research activities are closely linked to ELI, the largest laser centre in Europe open to external users. One pillar of ELI (ELI-ALPS) is under construction in Szeged. It will be equipped with laser and secondary sources with several unique parameter combinations which will be available for the first users from 2018 on.

National coordinator of the RI group:
HAS Wigner Research Centre for Physics, Institute for Solid State Physics and Optics

Contact: Péter Dombi
Email: dombi.peter@wigner.mta.hu
Website: https://wigner.mta.hu/

Partners: BME; ELI HU nonprofit Ltd.; University of Szeg; MTA Atomki; PTE; Bay Zoltán Nonprofit Ltd.

ESFRI connection: XFEL; ELI

Status of the RI group: under implementation

Background information
The working group is coordinated by Péter Dombi, head of the "Ultrafast nanooptics" MTA/Wigner "Momentum" Research Group, and also head of the ELI-ALPS Scientific Applications Division. Other participants are domestic laboratories engaging in significant, laser-related research. The closest link between the laboratories is ELI-ALPS in which all laboratories are involved in some way.

Aim of the RI group
In its specific research field, each laboratory has a modern research infrastructure area even by international standards, which have been listed in the introduction. In addition to the working group members, a number of institutions specialising in laser technology deal with laser applications in some form. It is essential to involve these institutions primarily in ELI-ALPS research projects.

7.4. PHYSICAL SCIENCES AND ENGINEERING

ELI-ALPS (EXTREME LIGHT INFRASTRUCTURE-ATTOSECOND LIGHT PULSE) RESEARCH INFRASTRUCTURES GROUP

Presentation of the RI group

The primary objective of the ELI Attosecond Light Pulse Source (ELI-ALPS) is to provide a wide spectrum of ultrashort pulse light sources to the international research community in the spectral range from soft x-rays (keV) to far-infrared (THz). The secondary objective of the facility is the scientific and technological development of lasers with high and/or average peak power. The ELI-ALPS equipment primarily enables basic research in physics, chemistry, materials science and biomedical sciences, but it will also be used for applied research and – as a ripple effect – for industrial application purposes.

The planned research infrastructure, currently under construction, will be able to produce and transmit few-cycle light pulses onto target objects with high reliability and stability. Depending on the spectral range, the absolute time length of these pulses ranges from a few attoseconds (soft x-ray range) to a few picoseconds (THz). The extraordinary photon fluxes of the attosecond pulses of ELI-ALPS enable experimental research on the latest issues of atomic, molecular and optical (AMO) physics. Pairs of excitation and probe pulses enable the observation of elemental ultra-fast processes in molecules and atoms and the typically charge dynamics processes on the surface of solids and in biological molecules. Besides examining atomic and molecular systems, these devices are also suitable for studying the collective excitation dynamics of solids and various linked systems. The extreme ultraviolet and x-ray pulses also enable biological, medical and materials science experiments.

The ultra-high temporal resolution provides significant additional research opportunities: the joint application of the attosecond "toolset" and the standard structural imaging techniques. Along a more advanced pathway and since diffraction of x-ray radiation provides high spatial resolution, the combined temporal and spatial resolution provided by the ELI-ALPS sources holds promise in visualizing ultrafast structural dynamics at the sub-fs and nm scales. Furthermore, the coexistence of attosecond pulses and PW-class lasers enables the analysis of relativistic light-matter interactions in time. The resulting new plasma diagnostic tools are particularly useful in understanding laser-driven particle acceleration, which can be used, for example, in medical applications and in the better understanding of inertial fusion energy – to name just a few important fields of application. Last but not least, the examination of interactions between the intense, high-frequency THz fields (as special secondary sources) and materials will also be possible, in synergy with the main attosecond research direction of the facility.

National coordinator of the RI group:
ELI-HU Non-Profit Ltd.

Contact: Károly Osvay
E-mail:karoly.osvay@eli-alps.hu
Website: https://www.eli-alps.hu/

Partners: University of Szeged

ESFRI connection: ELI-ERIC

Status of the RI group: under implementation, gradual commissioning from late 2017

Background information

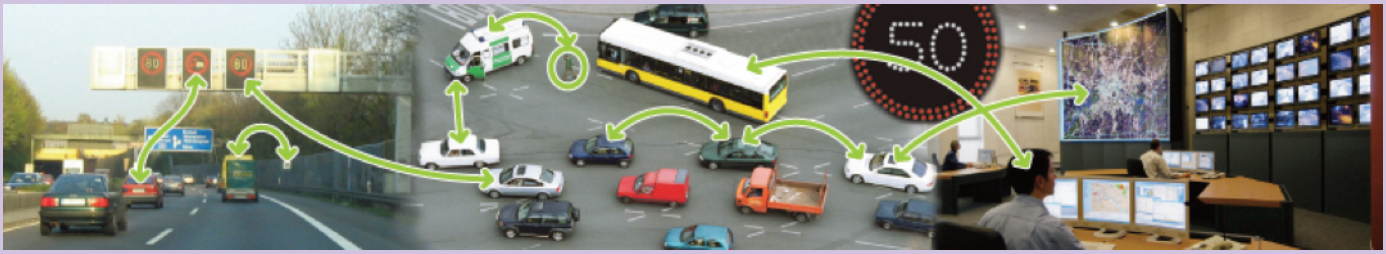
The ELI programme is implemented in three sites. The Attosecond Light Pulse Source (ELI-ALPS) research institute (Szeged, Hungary) hosts experiments on extremely short processes unfolding in atoms and molecules; the ELI-beamline (Czech Republic) focuses on generating short-pulse X-rays and on particle acceleration; and the ELI-NP (Romania) examines fundamental nuclear questions with ultra-powerful optical and gamma pulses . The three partner institutions – acting as a consortium – provide experimental research opportunities to national, European and international users, this way it functions as a "user facility".

Aim of the RI group

The attosecond research facility in Szeged provides a suitable environment for the laboratory-scale development of special high-energy laser systems to industrial partners, but the laser generation process in itself can bring innovation and economic benefits in many areas.

7.4. PHYSICAL SCIENCES AND ENGINEERING

VEHICLE AND TRANSPORTATION ENGINEERING RESEARCH INFRASTRUCTURE GROUP



Presentation of the RI group

The research platform is a higher education and research institution arrangement focusing on basic and applied research in line with a major national industrial development objective. The main overarching activities of the platform include research on autonomous vehicles and transportation systems and their preparation for use, as well as the integration of the relevant knowledge into higher education training programmes to ensure highly qualified future professionals. The scope of activities extends to the questions of roadway infrastructure development, the clarification of the legal issues relating to the design, testing and use of autonomous vehicles, participation in standardisation tasks, as well as international relations and economic-diplomatic representation.

National coordinator of the RI group:
Budapest University of Technology and Economics, Department of Automotive Technologies

Contact: Zsolt Szalay
Email: zsolt.szalay@gjt.bme.hu
Website: http://www.gjt.bme.hu/

Partners: BME Department of Control for Transportation and Vehicle Systems; BME Department of Automation and Applied Informatics; BME Vehicle Communication Research Laboratory; BME Department of Networked Systems and Services; SZE Research Centre of Vehicle Industry, Győr; HAS Centre of Excellence in Vehicle Technology Research (J3K), Győr; MTA SZTAKI; ELTE; SZTE; PPKE; PE, Veszprém

ESFRI connection: None

Status of the RI group: operating entities, with partitions under design and implementation

Background information
The vehicle and transportation engineering platform is coordinated by BME. RECAR, a cooperative inter-university research arrangement, also operates under the guidance of the coordinator. The platform consists of the following organised research entities:

1. Autonomous Vehicles and Transport Mobility Research Platform, BME
2. Automotive Research Platform of Excellence, SZE JKK
3. Platform for Autonomous Vehicles Testing
4. Research and Application of Artificial Intelligence Techniques, MTA SZTAKI
5. Research on the control techniques of large, complex and distributed systems, MTA SZTAKI

The above research platforms cover nearly all relevant tasks, and involve stakeholder research institutions in their work. The primary, defining relations are those between the above five platforms. A strategic committee consisting of the heads of the platforms is responsible for research coordination and for adopting a common research strategy. The coordinator participates in international projects, and in the EU GEAR2030 initiatives. Notably, trilateral university collaborations are successful between Austria, Slovenia and Hungary (Graz, Maribor, Budapest) in the topic of Cooperative Autonomous Vehicles.

Aim of the RI group
The group aims to coordinate and harmonise the tasks of domestic research centres in the field of vehicle and transportation engineering, and to promote the objectives through common project targets and complementary task assignment.

Status of the RI group:
The group's current infrastructure relies on the partner institutions' existing research infrastructures, which in turn demands continuous development to respond to the constantly and rapidly changing needs of the area.

7.4. PHYSICAL SCIENCES AND ENGINEERING

INDUSTRY 4.0 RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group

The research platform is an arrangement of higher education and research institutions focusing on basic and applied research and is aligned to the Industry 4.0 technologies, which is a fundamental pillar of the national industrial development goals. The main overarching activities of the platform include the theory and design of resource-efficient, robust production planning and management systems; robotics; the Industry 4.0 compliant innovation of the new models of cooperative and adaptive production and logistics networks; research supporting the methods as to the application and utilisation of such technologies; and the integration of the relevant knowledge into the higher education training programmes to ensure highly qualified future professionals. Research on technologies beyond production technology (such as CIT and 5G communications systems) is implemented in the framework of a partner network.

National coordinator of the RI group:
MTA Institute for Computer Science and Control, Research Laboratory on Engineering & Management Intelligence

Contact: László Monostori
Email: monostori.laszlo@sztaki.mta.hu
Website: www.sztaki.hu

Partners: BME Department of Control for Transportation and Vehicle Systems; BME Department of Automation and Applied Informatics; BME Vehicle Communication Research Laboratory; BME Department of Networked Systems and Services, Vehicle Communication Research Laboratory; SZE Research Centre of Vehicle Industry, Győr; MTA Centre of Excellence in Vehicle Technology Research (J3K), Győr.

ESFRI connection: None

Status of the RI group: operating entities, with some partitions in the design and implementation phase

Background information

The group is a network of educational and research institutions coordinated by MTA SZTAKI Research Laboratory on Engineering & Management Intelligence. Its main task is to represent Industry 4.0 objectives in Hungary and coordinate the relevant research activities. The group consists of the following organised research entities:

1. Industry 4.0 Centre of Excellence in Research and Innovation, MTA SZTAKI
2. Industry 4.0 Technology Centre, BME.

Taking into consideration the network of industrial and academic research partners located at individual sites, the two platforms encompass nearly all competencies in this field. By commission of the Ministry for National Economy, the professional coordination of Industry 4.0 objectives in Hungary is vested in MTA SZTAKI that established the country's Industry 4.0 professional representative forum comprising more than 60 domestic industrial stakeholders. The primary, prevalent relations are those between the above two platforms. A strategic committee consisting of the heads of the platforms is responsible for research coordination and for adopting a common research strategy. The coordinator takes part in numerous European projects (H2020) and other research cooperation relationships aiming at the international representation of the topic.

Aims of the RI group

Establishment of a common organisation for the representation of Industry 4.0 research; coordination and harmonisation of the tasks of the relevant domestic research centres, and promotion of the objectives through common project targets and complementary task assignment. The rationalisation of often costly infrastructural investments and providing cooperative access to resources are also priorities. The primary goal of the group is to create a flagship domestic research base using a shared infrastructure, and to join Industry 4.0 innovation efforts on the international stage.

Status of the RI group:

The current infrastructure of the RI group relies on the existing research infrastructure of MTA SZTAKI developed from GINOP and H2020 funds. The Industry 4.0 model centre in Győr is particularly important.

7.5. Social and Cultural Innovation

Although the area of social sciences and humanities is rather fragmented, from the perspective of research infrastructure demand it looks quite uniform. Almost all fields of sciences are mainly concerned with collecting, analysing and evaluating data for scientific or policy decision-making. These tasks require the creation and operation of a database which is as complete as possible. Thus, in this domain, primarily those facilities are considered research infrastructures which enable the establishment, digitisation and classification of the desired data, the setup of databases, and ensure access to and analysis of such data later on.

Almost all areas of social sciences (economics, political science, sociology) generate standardised empirical data by processing large samples, which often serve as the basis for governmental decision-making. Building up, publishing and analysing archives are among the activities that present the highest infrastructural demand. Extracting information from text and voice archives is also a new challenge, which is addressed using linguistic and information-based technologies. The development of language and speech technologies is highly facilitated by the rapid evolution of information technology devices.

Research infrastructure groups are presented in the domains where Hungary has a strong domestic researcher community whose members actively contribute to the surveys of large international networks on social sciences, health, aging and common language resources.

7.5. SOCIAL AND CULTURAL INNOVATION

ESS-HU (EUROPEAN SOCIAL SURVEY) RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group

The European Social Survey (ESS) was initiated in 2001 by the European Commission with the aim of gaining comparative data every two years about the demographic and social conditions of European societies, political and public preferences of citizens, and changes in social attitudes and action-guiding values. Perhaps the greatest strength – and value – of ESS is that it applies very strict and constantly monitored data collection methodology which has made it one of the methodologically soundest collaborative international endeavours, in Europe. The data characterising the society of the participating countries are developed jointly, using the same methodology, ensuring that survey results are comparable across Europe. The survey consists of varying and standard components: varying question blocks address current social phenomena and problems at European level and change by survey wave, while the standard blocks collect information on the main socio-economic characteristics of the population, political and public attitudes, value preferences – such data are available about the past sixteen years. The varying question blocks (the so-called rotating modules) focused on aging and related social attitudes, and on behaviours relating to welfare systems in 2008, and addressed the topics of work, family and well-being in 2010. In the 2012 wave , rotating modules dealt with the complex issues of personal and social well-being, and attitudes towards democracy. The seventh wave in 2014 focused on attitudes towards migration and state of health. behavior increasing risk of diseases. In 2016 rotating modules inquired about knowledge and attitudes concerning climate change and energy consumption and repeated the 2008 questions of welfare attitudes. The data produced bi-yearly by the RI allows for timely and cross national or cross regional comparison. It is openly accessible to anyone and thus is widely used in the academic scene, in policy making as well as higher education. Since its inception, over 100,000 people have registered as ESS users. Around 64% of registered ESS users are students. A further 27% can be classed as academics (research/ faculty/ PhD) and just under 10% come from other domains (e.g. policy, NGOs, businesses, private individuals). Near to 1000 academic papers published in double blind peer reviewed academic journals ha vused ESS data. In University education educators are using the ESS to support the delivery of both methodological and topical modules. The robustness of the survey data , and the clarity of the accompanying methodological annexes, provide lecturers with real-world examples with which to illustrate the theoretical aspects of their presentation on research methods.

National coordinator of the RI group:
HAS Centre for Social Sciences, Institute for Sociology; and Institute for Political Science

Contact: Vera Messing
Email: messing.vera@tk.mta.hu
Website: http://ess.tk.mta.hu/

Partners: MTA KRTK; Central European University; BCE Faculty of Social Sciences and International Relations; ELTE Faculty of Social Sciences; ELTE Faculty of Law; ELTE Faculty of Education and Psychology; PPKE Faculty of Social Sciences; PPKE Faculty of Law and Political Sciences; SZTE Institute of Social Sciences; SZTE Faculty of Law; PTE Faculty of Law; PTE Institute of Social and Media Studies; DE Faculty of Law; DE Department of Sociology and Social Policy; ME Faculty of Law and Political Sciences; ME Faculty of Arts; SZE Faculty of Law and Political Sciences; SZE Faculty of Economics and Social Sciences

ESFRI connection: ESS-ERIC

Status of the RI group: operating

Background information

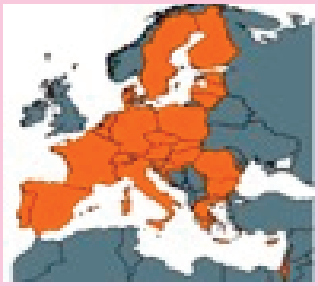
The RI coordinator MTA TK is responsible for research implementation, compliance of data collection with international standards, and professional and operative cooperation with the international partners (City University, London; NSD Norway; The Netherlands Institute for Social Research; Universitat Pompeu Fabra, Spain; University of Essex, UK; University of Leuven, Belgium; University of Ljubljana, Slovenia). The ESS database is open-access, so the researchers, lecturers and students of the Hungarian partner institutions can use it for educational and publication purposes. In Hungary nearly 2000 users have registered to ESS most of whom have downloaded and used the data. Many institutions of the Hungarian scientific and academic sector participates in the wide utilisation of ESS data, mainly in education and for dissertations in the fields of methodology, sociology and political science. In addition, over the past few years, more than a hundred scientific publications authoed by Hungarian scholars relied on ESS information. Furthermore, after each wave, the most important survey results are presented in a special issue of a peer-reviewed journal, and there is also an annual conference dedicated to ESS. In June 2018, MTA TK hosted the two-day Central and Eastern European Regional ESS scientific conference. The group also participates in the series of events of Hungarian Science Festival. To promote domestic utilisation, the ESS TK team plans to organise workshops for universities and research centres to raise awareness of the infrastructure.

Aim of the RI group

The aim of the RI group is to gain comparative data about the demographic and social conditions of European societies, political and public preferences of citizens, and changes in social attitudes and action-guiding values. The RI provides data to Hungarian research and academic communities, which are used in higher education, publications and other scientific activities . All ESS waves provide abundant sources to dozens of scientific publications and a number of university courses.

7.5. SOCIAL AND CULTURAL INNOVATION

SHARE-HU (SURVEY OF HEALTH, AGEING AND RETIREMENT IN EUROPE) NETWORK RESEARCH INFRASTRUCTURE GROUP



Presentation of the RI group

The Survey of Health, Ageing and Retirement in Europe (SHARE) is a multidisciplinary, biannual follow-up research covering all Europe. The project surveys a representative sample of the 50+ population on issues such as health, employment, income, financial situation and social relations. SHARE survey data provide a unique basis for international comparisons on topics related to aging. Since 2004 SHARE has reached 120,000 persons aged more than 50 years in Europe, who gave altogether more than 297,000 interviews over the years. Hungary was involved in SHARE surveys in 2011 and 2017. SHARE data are available to researchers free of charge subject to a declaration of confidentiality. The 2017 survey was a retrospective one, giving an insight into the current financial and social situation of the 50+ population, as well as into the path leading there (childhood health, labour market story, social relationships).

SHARE data enable multidisciplinary research, and provide considerable information for public decision-making, including in the following questions: What are the causal relationships between health and socio-economic status? Can these relations be influenced by welfare benefits and health policy? How does the increase of the retirement age influence the mental and physical health of the population? How do intergenerational relationships change in a changing society?

National coordinator of the RI group:
HAS Centre for Economic and Regional Studies

Contact: Anikó Bíró
Email: biro.aniko@krtk.mta.hu
Website: www.krtk.mta.hu

Partners: MTA KRTK; Tárki Social Research Institute Ltd.

Further institutions using the SHARE database: BCE; BME; DE; CEU; KSH Hungarian Demographic Research Institute; PTE; SE; SZTE

ESFRI connection: SHARE-ERIC

Status of the RI group: under implementation

Background information

MTA KRTK plays a prominent role in the field of economic research in Hungary. As the professional coordinator of SHARE, it primarily develops the content of the questionnaire, ensures the high professional quality of data collection, and cooperates with international SHARE partners. So far, the surveys were performed by Tárki Zrt in Hungary. The group is professionally coordinated by Anikó Bíró (research fellow at MTA KRTK Institute of Economics), whose research focuses on the economics of health and aging.

Aim of the RI group

The group aims to biennially implement the SHARE surveys in Hungary, and to expand the scope of the database users. The group also plans to link Hungarian SHARE data to administrative data. Due to the panel nature of the SHARE sample, future surveys can provide more insight into the changes of the health, economic and social situation of the population over 50 years, as well as into the relevant key influencing factors. The group intends to raise awareness of the SHARE database in universities and research institutions, emphasising its potential in economic and sociological research on aging.

7.5. SOCIAL AND CULTURAL INNOVATION

CESSDA-HU (CONSORTIUM OF EUROPEAN SOCIAL SCIENCE DATA ARCHIVES) NETWORK RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group
Since its foundation in 1976, CESSDA has operated as an umbrella organisation for European national social science data banks and archives. CESSDA has be included in the ESFRI Roadmap since 2006, and received ERIC status in 2017. The headquarters of CESSDA ERIC is in Bergen, Norway.

CESSDA ERIC aims to build a broad, comprehensive and long-term sustainable funding system for the national and international participants of social sciences research.

The task of CESSDA ERIC, as stated in its statutes, is to provide a full scale sustainable research infrastructure enabling the research community to conduct high-quality research in the social sciences contributing to the production of effective solutions to the major challenges facing society today and to facilitate teaching and learning in the social sciences.

National coordinator of the RI group:
Tárki Social Science Databank

Contact: Péter Hegedűs
Email: peter.hegedus@tarki.hu
Website: http://tarki.hu/adatbank

Partners: BCE Department of Sociology and Social Policy; DE Institute for Political Science and Sociology; ELTE Faculty of Social Sciences; MTA TK; SZTE Department of Sociology; Tarki Social Research Institute Ltd.

ESFRI connection: ESS-ERIC; SHARE-ERIC

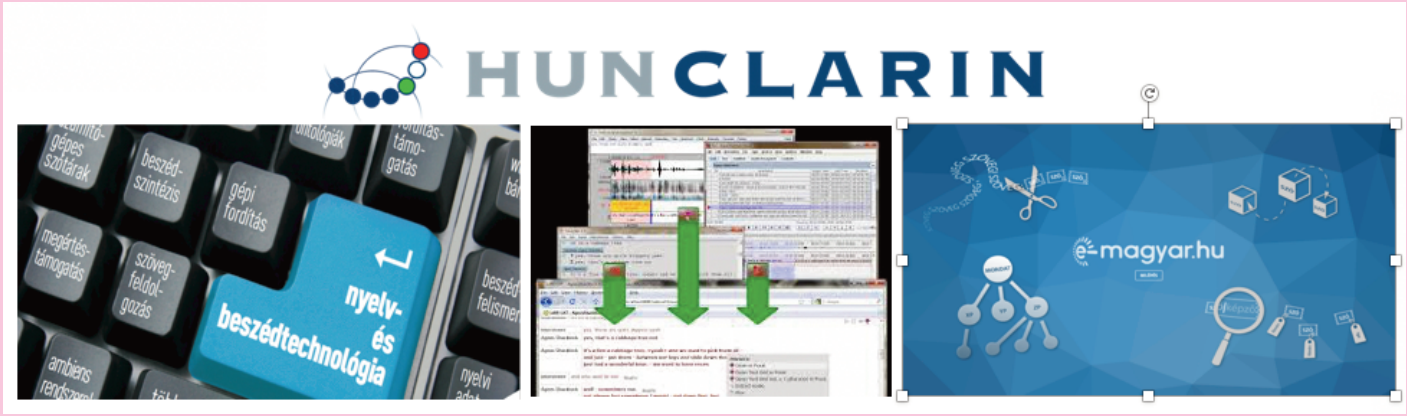
Status of the RI group: implemented

Background information
The Tárki Databank is operated by the nonprofit Tárki Foundation. Over the past three decades, they have archived more than 800 social research databases ready for second analysis.
Tasks: 1. preserve national and international empirical social research databases in a digital form; partners include research institutes, university faculties and departments engaged in research in the social sciences; 2. propagate the archived databases in the national and international scientific communities (researchers) and in educational institutions (lecturers and students); 3. stimulate cost-efficient research by allowing second analyses. The goal is the development of the social research infrastructure in Hungary and the support of a broader range of research communities and stakeholders with databank services.

Aim of the RI group
The primary goal of CESSDA ERIC is to extend membership not only to the EU member states but also to the wider European research environment. The expansion of services provided by the organization is also a priority.

7.5. SOCIAL AND CULTURAL INNOVATION

HUNCLARIN (COMMON LANGUAGE RESOURCES AND TECHNOLOGY INFRASTRUCTURE) NETWORK RESEARCH INFRASTRUCTURE GROUP



Presentation of the RI group

HunCLARIN is the strategic research infrastructure network of leading Hungarian research and development knowledge centres in language and speech technology. It aims to support research and innovation with language technology tools and resources, especially in the field of humanities and social sciences.

The present nine members (1 coordinator and 8 partners) of HunCLARIN represents the forefront of Hungarian language and speech processing. The language technology resources (e.g. mono- and multilingual and thematic corpora) and tools (e.g. morphological analysers) developed by them enable, among other things, the content analysis of large corpora (e.g. from a particular historical era) and the automatic coding of psychological meanings.

National coordinator of the RI group:
HAS Research Institute for Linguistics

Contact: Tamás Váradi
Email: varadi.tamas@nytud.mta.hu
Website: http://clarin.hu/

Partners: BME MOKK; BME TMIT; MTA SZTAKI; DE; SZTE; Morphologic Ltd; MTA-PPKE ITK Hungarian Language Technology Research Group; MTA TTK

ESFRI connection: CLARIN-ERIC

Status of the RI group: under implementation

Background information

The RIs comprising the HunCLARIN are coordinated by the MTA Research Institute for Linguistics which was a founding member of the CLARIN project and also played a key role in the preparatory phase of the CLARIN. In addition to the coordinator, currently eight institutions/research groups are contributing to HunCLARIN as partners, which are the most outstanding representatives of computer language and speech processing in Hungary. The quality of participating RIs is clearly illustrated by such projects as the European Space Agency's language-based psychological state monitoring programme or the grammar and spell checker plugins developed for word processors.

Aim of the RI group

The main objective of HunCLARIN is to support scientific research by making language technology and language resources easily accessible. This essentially requires a web interface and the underlying technical infrastructure through which (registered researchers) can easily access all RIs in the group and can compare the tools with each other and CLARIN applications in other languages. This significantly simplifies the channelling of Hungarian language and speech technology into high-profile European work, since language technology tools and resources are already interoperable in (and between) a number of other European members of CLARIN .

7.6. E-infrastructures

In recent decades, the international embeddedness and professional excellence of scientific research have been enabled by various info-communication technology (ICT) developments and applications. Therefore, it is of strategic importance to keep the ICT infrastructure at a high technological level for Hungarian institutions and businesses involved in RDI. In this domain the main aim is to preserve network operability and continuously improve the level of service, which form part of the core activities of the Governmental Information Technology Agency (KIFÜ). Currently, the commonly maintained GEANT network ensures the high-speed connection between member states' national networks.

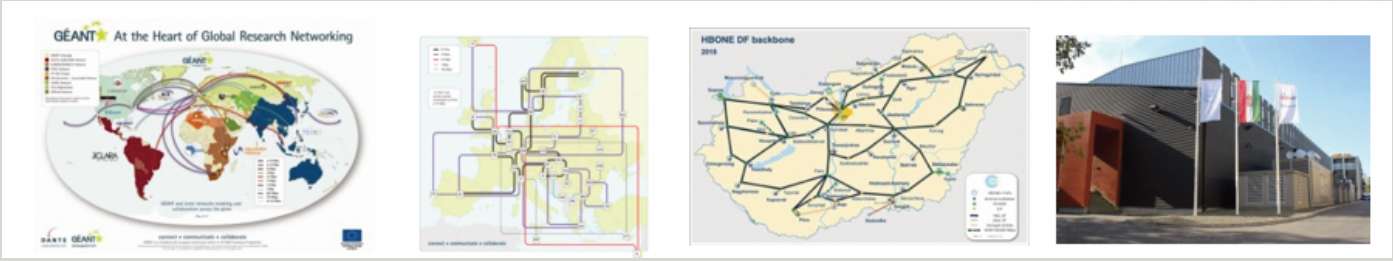
Apart from the stable functioning of the network, the collection, storage, processing and analysis of scientific results also demand for very extensive and reliable computing capacity. This is especially true of the collection, storage and immediate or delayed processing of big data generated by large-scale infrastructures. As a result of the KIFÜ's capacity development programme for universities, the users (research groups) have gained a competitive advantage compared to the neighbouring countries.

The situation has been further improved by the HAS Wigner Research Centre for Physics in Csillebérc, Budapest, by deploying a 4 MW unit of the Wigner Data Centre. Currently, the Data Centre mainly supports the particle physics research in CERN, but the Hungarian researcher community also has additional capacities provided by HAS Cloud and Wigner Cloud services. Apart from ensuring the daily use, the HAS Cloud unit operated by MTA SZTAKI can also be used for performing development tasks.

Initially, e-infrastructure mainly supported researchers in the field of physical sciences, but today researchers from the fields of medicine, life sciences, humanities and social sciences have not only caught up with but also surpassed natural scientists by presenting new needs which pose new challenges to the designers and operators of e-infrastructures.

7.6. E-INFRASTRUCTURES

E-INFRASTRUCTURE RESEARCH INFRASTRUCTURE GROUP



Presentation of the RI group

E-infrastructure that complies with European standards and demands, featuring a complex portfolio of services, with full connection to the approx. 40 European National Research and Education Network (NREN), and indirect connection to an additional approx. 60 non-European national research e-infrastructures. Covers all internationally accepted functions of ICT-based communication and cooperation, information processing and data storage, providing all research areas with e-infrastructure. The e-infrastructure of KIFÜ (Government Information Technology Agency), as part of the GÉANT infrastructure (European ICT infrastructure) and the PRACE infrastructure (pan-European supercomputing infrastructure), provides stable and full-featured connection and cooperation for accessing all research institutions and researchers in Europe, including all European research infrastructures (ESFRI, ERIC and others) building on the tools of multimedia information management, resource and service virtualisation, federal identification etc. As of 2017, the research network connects more than 1.7 million domestic users to international educational and research network with a speed of up to 500 Gbps. The distributed HPC facility operated by KIFÜ offers a capacity of over 448 Tflops (8900 CPU+GPU cores) and 8 PB hard drive storage to researchers in the country and the region. This is completed with the C4E cloud system with more than 2600 cores and 15 PB storage capacity available to the domestic research and education community. Without them the Hungarian roadmap of research infrastructures would collapse, due to the lack of online availability of the domestic and international infrastructure facilities and services. Research and development is supported by the HAS Cloud computing capacity launched in 2016 and accessible through the KIFÜ network, whose twin modules are located in the Wigner Data Centre (MTA Wigner FK) and the MTA SZTAKI. In the 4 MW Data Centre currently 70,000 CPU cores and 80 PB disk space support CERN HL-LHC research programmes (around 10,000 users) over a 300 Gbit/s direct connection. In parallel to this, the HAS Cloud and the Wigner Cloud established in 2015 have a combined capacity of 2500 CPU cores (5000 virtual cores) and 2 PB disk space. The Wigner Cloud has launched an integrated GPU programme in 2018 with 8 NVIDIA Tesla V100 units featuring a total performance of 62 Tflops in the case of double-precision calculations and 1 Pflop in the case of tensor calculations. This domestic capacity is currently able to serve approximately 1000 Hungarian and regional researchers.

National coordinator of the RI group:
KIFÜ (Government Information Technology Agency) in cooperation with the HAS (Hungarian Academy of Sciences) institutes

Contact: KIFÜ, Vice-Presidential Division of Infrastructure, Department of Research and Development
Email: intproject@niif.hu
Website: www.kifu.gov.hu

Partners: MTA Wigner FK; MTA SZTAKI
Further partners: 57 research institutes; 26 universities; 5600 primary and secondary schools; 580 libraries and other public collections, more than 1.7 million users

ESFRI connection: PRACE, HL-LHC, ELI, XFEL (through the GEANT and KIFÜ network)

Status of the RI group: distributed, multi-site

Background information

The foundations of the Hungarian e-infrastructure were laid down by the IIF Programme launched in 1986-87, and later the NIIF (National Information Infrastructure Development) Programme. During the gradual development of the domestic research network and expanding international relations, the NIIF Institute was established in the early 1990s to operate and develop the NIIF Programme and the HUNGARNET Association to represent the interests of stakeholders. The Institute was integrated into KIFÜ by a government decision in 2016.

Aim of the RI group

The mission and vision have not changed from the beginning: to provide an internationally competitive, stable and sustainable e-infrastructure to the research and education sector in Hungary. Sustainability is ensured by the government decree on the NIIF Programme and by the active participation in national and international development programs. The strategic objectives derived from the mission and the vision include the development of the entire service portfolio, enhanced institutional and EC cooperation and participation in major international projects. The excellent e-infrastructure parameters will facilitate innovative national research and an open education that promotes creativity. The HAS Cloud in the Wigner Data Centre, combined with the computing capacity of the Wigner Cloud can simultaneously serve nearly 1000 potential national and Central European users in the fields of particle physics, gravity research, artificial and intelligent materials, brain research, bioinformatics and computational sciences. The capacity can also be substantially extended.

7.6. E-INFRASTRUCTURES

5G COMMUNICATIONS SYSTEMS AND APPLICATIONS RESEARCH INFRASTRUCTURE GROUP

Presentation of the RI group

The research platform is a higher education and research institution arrangement focusing on basic and applied research and is aligned with 5th generation mobile communication technologies, which is a fundamental pillar of national industrial development goals. The main overarching activities of the platform include research on 5G basic technologies and particularly their application, as well as the integration of the relevant knowledge into higher education training programmes to ensure highly qualified future professionals. The areas of applications include autonomous vehicle technologies, robotics, IoT detection technologies and communication-intensive parts of Industry 4.0 goals. These research activities are performed by the group in collaboration with its partners.

National coordinator of the RI group:
BME Centre for Higher Education and Industrial Cooperation (BME FIEK)

Contact: Charaf Hassan
Email: hassan@aut.bme.hu
Website: https://www.bme.hu/FIEK

Partners: BME Department of Automation and Applied Informatics; BME Department of Control for Transportation and Vehicle Systems; BME Vehicle Communication Research Laboratory; BME Department of Networked Systems and Services; SZE Research Centre of Vehicle Industry, Győr; HAS Centre of Excellence in Vehicle Technology Research (J3K), Győr; MTA SZTAKI; ELTE; SZTE; PPKE; PE, Veszprém

Status of the RI group: operating entities, with partitions under design and implementation

Background information

The BME Centre for Higher Education and Industrial Cooperation (BME FIEK) comprises a research research and development network which is primarily concerned with 5G ICT research and the development of advanced applications based on it. The platform consists of the following organised research entities:
6. 5G Smart Campus. 5G Application Research Platform, BME
7. Industry 4.0 Technology Centre, BME
The two research platforms cover nearly all relevant tasks. In addition to the two dominant platforms, the RI group also incorporates further research centres active in this area and operating in collaboration with one of the two platforms. The primary, defining relations are those between the two platforms. A strategic committee consisting of the heads of the platforms is responsible for research coordination and for adopting a common research strategy. The coordinator takes part in both European projects (H2020) and other research cooperation relationships aimed at the international representation of the topic.

Aim of the RI group

Establishment of a common organisation for the representation of 5G technology research; coordination and harmonisation of the tasks of the relevant domestic research centres, and promotion of the objectives through common project targets and complementary task assignment. The rationalisation of often costly infrastructural investments and ensuring cooperative access to resources are also priorities. The primary goal of the group is to create a flagship domestic research base using a shared infrastructure, and to contribute to 5G research and development efforts on the international stage.

Status of the RI group:

The group's current infrastructure relies on the partner institutions' existing research infrastructures, which demands continuous development to respond to the constantly and rapidly changing needs of the area. The involvement of industrial partners in RI investments is a priority.

8. Presentation of funded research infrastructure projects

The funding schemes described in Chapter 4 have enabled the **implementation of significant RI developments in recent years** in the framework of competitive public funding programmes.

Since 2015, many **calls for proposals** have been announced independently or as part of the RDI funding programme aimed at the development of research infrastructures. The RI development projects financed from national or EU sources strengthened the knowledge base and international cooperation relations. Projects submitted to the calls announced by the NRDI Office and the managing authorities were assessed by expert panels based on excellence and future potentials, with a particular focus on increased research cooperation and networking. It was also expected to use the procured equipment for educational purposes, and in many funding schemes the level of involvement of young people, the openness of the given infrastructure and the impact on regional development were also among evaluation criteria.

Importantly, RI development projects were **required** to be directly or indirectly aligned with the national sectoral priorities or smart technologies defined in the S3. The funding schemes also anticipated projects to contribute to the achievement of internationally outstanding scientific results, as well as to scientific excellence, stronger scientific positions for Hungary, the national/international networking of research infrastructures, and the international competitiveness of the domestic RDI system. However, as the development level of Hungarian regions – and thus their access to the structural funds – vary significantly, a **large part of the development projects were implemented in the convergence regions.**

The following part of the chapter introduces a few recent RI development projects which have **special importance** both in terms of national R&D and international connection.

Strategic workshop addressing the technological challenges of renewable-based

HAS Centre for Energy Research

Project code:
VEKOP-2.3.2-16-2016-00011

Project leader institution:
HAS Centre for Energy Research

Project leader:
Béla Pécz

Project leader's contacts:
pecz@mfa.kfki.hu

Project partners:
MTA Wigner FK; MTA EK MFA; MTA EK EKBI

Amount of funding:
HUF 564,063,112

Website:
http://www.mfa.kfki.hu/hu/VEKOP-megujulo

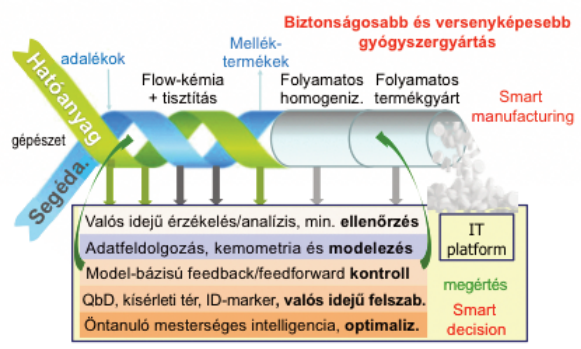
Project description:
The project takes advantage of synergies between the HAS Centre for Energy Research and the site (HAS Wigner Research Centre for Physics), and is fully aligned with the strategy of the former. The thematic project is closely related to infrastructure investment project No. VEKOP-2.3.3-15-2016-00002 in the framework of which the HAS Centre for Energy Research purchases, installs and operates the first spherical aberration corrected TEM/STEM microscope in Hungary and then grants access to it for researchers, students and industry stakeholders. This project is fully supported by the Strategic Workshop financed procurement of a dual beam microscope (SEM+FIB), particle separator, Raman microscope, potentiostat, gas chromatograph. The resulting workshop will offer excellent facilities for industrial development activities.

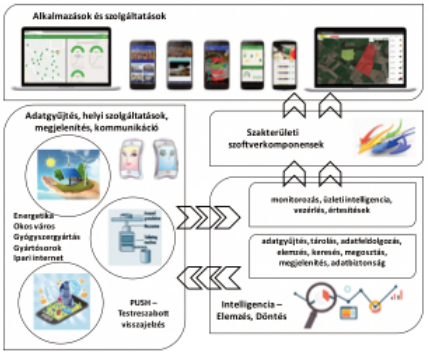
The complete transformation of our energy system is the biggest challenge of the 21st century. Scientific research will play a major role in making the energy sector meet supply security, sustainability and environmental requirements. This projects is primarily aimed at photovoltaic energy production and storage, and research on other environmental effects.

- The development of new types of materials (particularly materials with new optical properties) for photovoltaic power stations, mainly by using lead- and tin-based perovskite type materials and mineral (pyrite and CZTN) type materials.
- Computer simulation of a smart grid in the case of network- and household-sized photovoltaic (PV) systems.
- Development of applications for renewable energy storage: the aims is to develop catalysts for electrolytic hydrogen production and to explore the potentials of carbon nanoparticle-fed supercondensators.
- Laser energy transmission: the transmission of energy from a high-intensity laser source, which can be focused to optimum size at the PV inverter with special adaptive optics, to moving and mobile assets.
- Examination of the environmental impact of nanoparticles with new methods – as the impact of new renewable energy related nanotechnology procedures and biomass utilisation on the composition of atmospheric aerosols is little known.
- Publication of cutting-edge research results – the project assigns great priority to the production methods, spectroscopy, separation materials testing and certification procedures of nanostructured materials, and the evaluation of such data.

Integrated, smart technologies – synergy programme: Focus on the energy and pharmaceutical industry – Establishment of an innovative technologies and services centre (laboratory network) in the fields of ICT, energy and pharmacy.

BME Centre for Higher Education and Industrial Cooperation





Project code:
FIEK_16-1-2016-0007

Project leader institution:
Budapest University of Technology and Economics

Project leader:
László Kollár

Project leader's contacts:
kollar.laszlo@epito.bme.hu

Project partners:
Siemens Zrt.; Richter Gedeon Nyrt.; Nokia Solutions and Networks Kft.; Magyar Villamos Művek Zrt

Amount of funding:
HUF 3,959,244,693

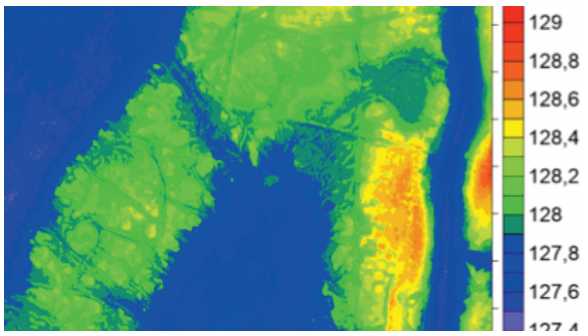
Website: http://fiek.bme.hu

Project description:
The consortium aims to put the coordination of university-industry research on a new footing, facilitate the practical application of research results, develop a partial or full private funding model for research, approximate university education to industry needs, and foster the further training of business professionals. Digitisation has enabled the development of new products, services and technologies in the energy and pharmaceutical industry which will also use the new information technologies (IT) to be developed by the consortium.
The programme boosts the competitiveness of interrelated scientific fields by creating a digital ecosystem through info-communication technology (ICT), which has become a horizontal sector in the economy. Thanks to the crosscutting and energizing potential of ICT, research results that already address industrial needs are quickly taken up by the relevant fields. The sound operation, control and sustainability of sub-programmes are secured by the application of common ICT principles and methods, thus providing a common platform.
The consortium intends to make the successful collaboration model available to other businesses in the future.
The BME Centre for Higher Education and Industrial Cooperation represents a new mindset at universities: it will organise research and development as a commercially profitable activity. The participation of partner companies in the management of the centre and the resulting best practices can substantially contribute to the approximation of the attitudes of higher education and the private sector.

Technical description/parameters of the research infrastructure:
Network of laboratories (infrastructure) to be established in the project: Pharmatech Model Laboratory (complex continuing pharmaceutical technology), Modular Hybrid Drives Laboratory (comprehensive examination of all components of the electric vehicle drives – engine, generator, converters, battery and combinations thereof – and of the entire system), Smart Power Laboratory (real-time laboratory development and testing of the energy management of a largely renewable reliant electricity system), Micro CHP Laboratory (exploitation of the energy potential of connected energy production) and IoT Test Network and (5G Ready) Laboratory.

International territorial water management and climate adaptation instruments centre

University of Debrecen, Institute of Water and Environmental Management



Project code:
GINOP-2.3.3-15-2016-0028

Project leader institution:
University of Debrecen, Faculty of Agricultural and Food Sciences and Environmental Management

Project leader:
János Tamás

Project leader's contacts:
tamas@agr.unideb.hu

Amount of funding:
HUF 712,009,545

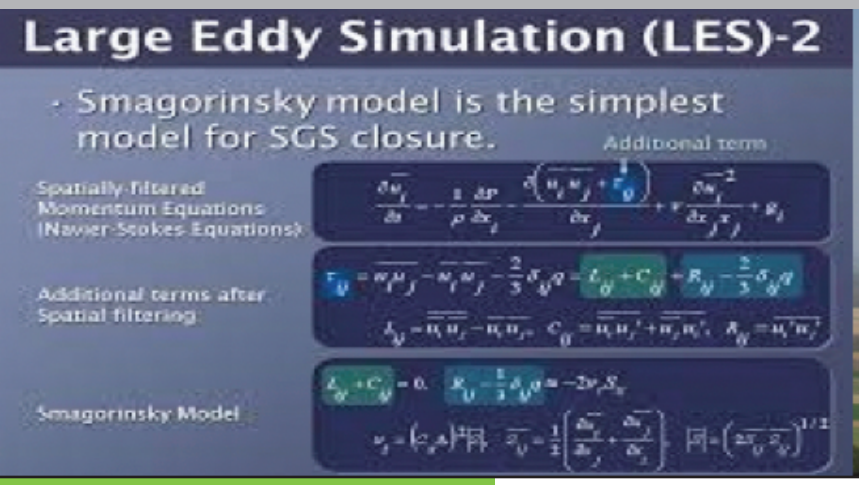
Website:
https://mek.unideb.hu/node/233

Project description:
The International River Basin Management and Climate Adaptation Centre will be launched in 2019 at the Water and Environmental Management Institute, University of Debrecen. The Centre will be a state of the art research facilities in Hungary and Central Europe in the agricultural water management discipline. The climate adaptation solutions to be developed here will bring significant breakthrough in addressing drought, inland waters and urban hydrology. The complex infrastructure is a unique system with two interconnected parts: hydrological measurement house and the controlled greenhouse research. The "agricultural" campus of the University of Debrecen is an ideal place for training, research and professional consulting. The hydrological measuring house contains a preparation room, instruments test sites and hydrological engineering measurement room as well. Instruments installed here include: watershed monitoring devices; field drainage plannig equipments; devices gauging geophysical and hydrological properties of soil; hydrological and hydraulic model tools; special research equipment of agricultural water management and irrigation technology; erosion control and land reclamation laboratory equipments; irrigation water quality protection devices and equipments for data-processing. The IT network will support the computerized data processing, water management planning and decision-making, the data collection system of the entire unit, and the data aquisition by ground water monitoring wells in the TransTisza monitoring areas. The irrigation technology, soil and water quality protection instruments, the related control units and the soil-plant systems used for holistic measurement purposes and characterising hydrological parameters are placed in the greenhouse. The power demand of the greenhouse and the local equipments will be met by a suistanable solar energy power system.

Technical description/parameters of the research infrastructure:
Infrastructure components to be procured in the framework of the project: experimental and demonstration tools; soil, water, weather and plant water balance gauges; groundwater monitoring system; dual polarized high-resolution precipitation ground radar; precision irrigation technology research infrastructure.
The unique infrastructure further enhances the multidisciplinary educational and research role of the University of Debrecen in the transboundary river basin of the Tisza River. The infrastructure enlargement implemented in the project will connect the institution's researcher bases with the domestic and international research network in the fields of agriculture, water management and environmental sciences. It generates projects in several areas of integrated river basin management, so it is related to drought and inland water management, water quality protection, and indirectly to hydrobiology, hydrochemistry and urban hydrology.

Development of an air pollution forecasting system which takes into account water-aerosol interactions in the atmosphere

University of Pannonia



Project code:
GINOP-2.3.2-15-2016-00055

Project leader institution:
University of Pannonia

Project leader:
András Gelencsér:

Project leader's contacts:
gelencs@almos.uni-pannon.hu

Project partners:
PTE; Hungarian Meteorological Service

Amount of funding:
HUF 819,120,657

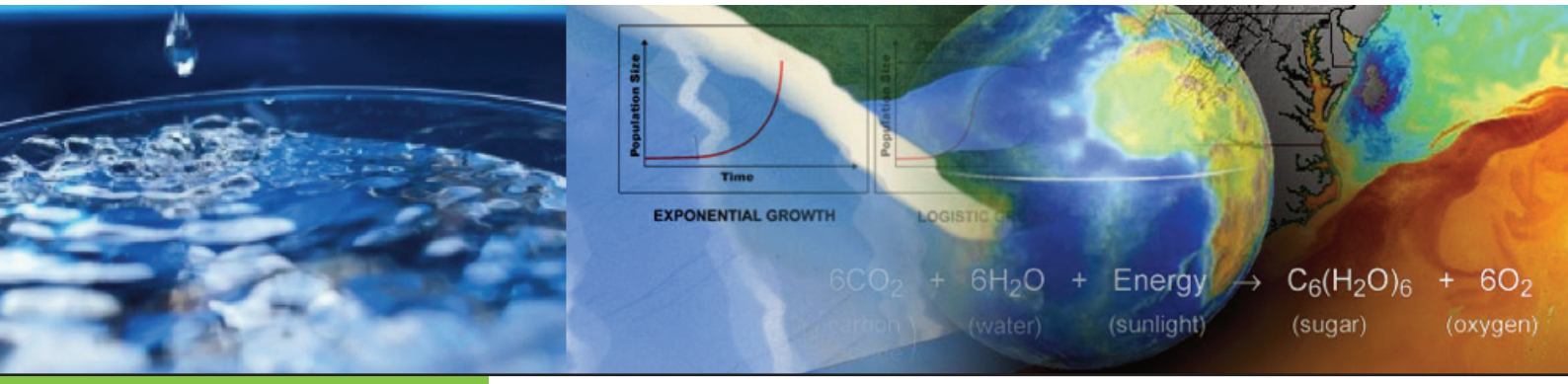
Website:
https://levegokemia.uni-pannon.hu/

Project description:
The better understanding and integration with atmospheric models of the interactions between air pollution and atmospheric water are one of the greatest challenges of atmospheric sciences. The hygroscopic growth of aerosol, its role in fog formation, the change in the radiation balance, and the effect of multiphase chemical reactions unfolding in fog and cloud water are still unclear in many details. The project employs a novel microphysical model for studying fog formation. The detailed microphysical model, which has been successfully used for other cloud types, takes into account how the size and chemical composition of aerosol particles influence the formation of fog water droplets, and models collisions between aerosol particles and water droplets. Cloud physical and chemical processes are modelled with the LES (Large Eddy Simulation) model which includes 1) interaction between aerosol particles and fog formation (nucleation, scavenging); 2) the effect of radiative processes on fog formation and inversion layer; and 3) the role of water droplets in scavenging atmospheric gases and the chemical reactions occurring in water droplets.

Technical description/parameters of the research infrastructure:
The project uses the ECMWF (European Centre for Medium-Range Weather) analyses to provide a numerical, dynamic, synoptic-scale description of weather conditions. These analyses provide initial and boundary conditions for the modelling of mesoscale processes, which relies on the internationally widely used WRF (Weather Research and Forecast) model. The soil model attached to the WRF provides information on soil structure, temperature and humidity, land use (e.g. arable land, forest, built-up area etc.), the albedo, and the percentage of vegetation cover. Data assimilation is performed by "nudging", a procedure developed by NCAR (National Centre for Atmospheric Research) and also used in the WRF. It defines the rate of concentration increase of air pollutants (mainly PM10) caused by stagnant cold air masses. PM10 forecast is performed with a chemical transport model (CTM), using a 0.1° × 0.1° spatial resolution grid point database for the model calculations. During the tests, we try to determine the group of meteorological parameters which are required for the accurate forecasting of high PM10 concentration caused by stagnant cold air masses. The project examines how the standard measurement of PM10 concentration is influenced by high humidity and fog occurring when large-scale temperature inversion occurs. For the more precise modelling of fog droplet formation, we also measure the chemical composition and size distribution of the droplets and the aerosol particles as well as the size distribution of fog particles and interstitial aerosol particles, and the result is used to model the effect of the inhaled air on human health.

Development of innovative photo-oxidation water treatment technology for removing organic micropollutants from biologically purified wastewater

ELTE TTK, Cooperative Research Centre For Environmental Sciences



Project code:
NKVP_16-1-2016-0045

Project leader institution:
ELTE TTK, Cooperative Research Centre For Environmental Sciences

Project leader:
Gyula Záray

Project leader's contacts:
zaray.gyula@okologia.mta.hu

Project partners:
Inwatech Környezetvédelmi Kft.; LightTech Lámpatechnológiai Kft.; MTA TTK

Amount of funding:
HUF 528,279,556

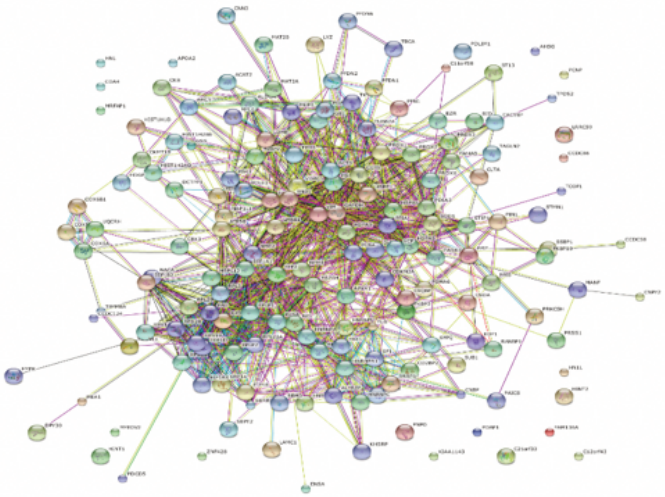
Website:
https://pak.elte.hu/NVKP_16-2016-0045

Project description:
Established in 2004, the ELTE TTK Cooperative Research Centre For Environmental Sciences employs biologists, chemists, physicists and earth scientists to work on task-oriented research projects using the infrastructures of individual departments for their research activity. In the project entitled "Development of innovative photo-oxidation water treatment technology for removing organic micropollutants from biologically purified wastewater" (NKVP_16-1-2016-0045, EUR 528,279,556), ELTE partnered with the MTA TTK Photochemistry Research Group, the VUV-UV radiation source developer Light Tech Ltd and the prototype container manufacturer Inwatech Kft. The project aims at developing LC-MS/MS methods for the determination of the concentration of organic micropollutants (e.g. pharmaceutical residues), necessary for the continued control of technological development, as well as at developing a highly effective photo-oxidation procedure for the treatment of biologically purified wastewater using a combination of ozone and UV radiation. The project will result in a containerised water purifier suitable for the post-treatment of and effective removal of organic micropollutants from purified wastewater discharged from water treatment plants of small villages into smaller recipient water bodies (streams). The solution also has the potential to be later used for the decontamination and further purification of drinking water.

Technical description/parameters of the research infrastructure:
- Inductively coupled plasma ion source high-res mass spectrometer for the simultaneous elemental analysis of inorganic constituents
- Analyser suitable for the determination of the total organic and inorganic carbon content
- Microwave-assisted exploratory equipment for the examination of suspended solids
- High pressure ultra-high performance liquid chromatography-quadrupole time-of-flight mass spectrometry (UHPLC/Q-TOF-MS) for the identification and quantitative determination of organic micropollutants of biological purified wastewaters and for the identification of degradation products generated during photo-oxidation

Bioanalytical instrument set for the molecular and cellular examination of candidate drugs

University of Debrecen, Faculty of Medicine



Project code:
GINOP-2.3.3.-15-2016-0020

Project leader institution:
University of Debrecen, Faculty of Medicine

Project leader:
József Tőzsér

Project leader's contacts:
tozser@med.unideb.hu

Amount of funding:
HUF 883,937,823

RI type: Distributed

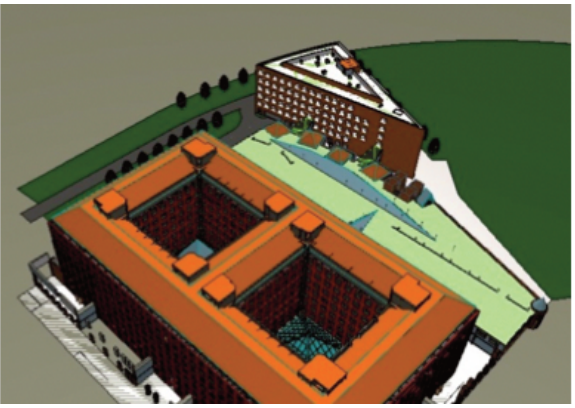
Website: https://kancellaria.palyazatok.unideb.hu/hu/node/74

Project description:

- Research groups at the University of Debrecen, Faculty of Medicine (DE ÁOK) do basic and applied research on cellular processes governing various diseases with the aim to provide up-to-date, useful knowledge to medical students who will be able to readily use it in practice to improve medical treatments and patients' quality of living. One of the priority R&D directions in the University of Debrecen focuses on a wide range of proteins, particularly on their role in diseases and on their potential therapeutic use. The DE ÁOK has been operating high-quality core facilities organized into a network for more than a decade, providing access for both internal and external research groups to the instruments, methodology and technical background that are essential for high quality research and competitive knowledge.
- The instruments procured in this project aim to extend the instrument park of the Proteomics Core Facility (PCF, professional leader: József Tőzsér), the HTS Core Facility (HTCF, person in charge of instruments: Tamás Bíró), the Biomolecular Interaction Core Facility (BICF, headed by Ferenc Erdődi) and the Molecular Cellular Analytics Core Facility (MCACF, persons in charge of instruments: László Csernoch and György Panyi) with instruments suitable for protein analytics and the examination of protein-ligand interactions.
- Technical description/parameters of the research infrastructure:
- Transcend II TLX-1 Turboflow and Thermo Orbitrap Fusion Tribrid high-resolution and high-precision LC-MS mass spectrometer with attachable nanoHPLC and software with Computing server configuration
- Microscopic/electrophysiology system: LSM 880 microscope/electrophysiology module
- Envision multiplate reader two detector dual emission system
- NanoTemper's innovative microscale thermophoresis products for protein-protein interaction research: Monolith NT.115Blue-Red, Monolith NT.LabelFree

Establishment of a molecular biomarker research and service centre

Eötvös Loránd University, Centre for Higher Education and Industrial Cooperation in Biotechnology



Project code:
FIEK_16-1-2016-0005

Project leader institution:
Eötvös Loránd University

Project leader:
Imre Kacskovics

Project leader's contacts:
imre.kacskovics@ttk.elte.hu

Project partners:
MTA TTK; CRU Kft.; Servier Kutatóintézet Zrt.

Amount of funding:
HUF 2,558,627,617

RI type: Single-site

Website:
https://fiek.elte.hu/

Project description:
Modern, personalized therapies are essentially built on molecular diagnostics, that is, on the analysis of so-called molecular biomarkers. Molecular biomarkers are used to identify the best treatment for certain diseases or the monitoring of the efficacy and safety of the treatment. Such analysis requires very extensive scientific knowledge which is provided at a high level and capacity by Lágymányos Campus, ELTE and MTA TTK. The consortium created by ELTE, MTA TTK, Servier Research Institute CCLS and CRU Hungary Ltd launched its program with the long-term goal to lead domestic molecular biomarker research and to provide services in this area for the clinical and pharmaceutical industry, the national healthcare system and citizens.

12 research groups were established for the implementation of the research programme, 7 of which work at ELTE TTK and 5 at MTA TTK in collaboration with CRU and Servier researchers and experts. One of the pillars of the project is to establish an accredited molecular biomarker laboratory and to purchase the research and diagnostic laboratory equipment needed for the implementation. The laboratory will be located in a new building in the South Block of the ELTE Lágymányos Campus.

Major R&D instruments of the research groups and the molecular biology and immunobiology laboratory

Fluoro ELISA Plate Reader, Plate shaker, flow cytofluorometry (HTS), PCR devices, IVD gradient PCR machine, Veriti dx 96-well Thermal Cycler, fluorometer (Qubit starter KIT), DNA and RNA preparation device, Agilent Bioanalyzer, high performance chromatographic system, sterile laminar boxes, CO2 incubators, centrifuges, inverted and fluorescence microscopes, freezers etc. The operation of the FIEK is supported by a bioinformatics research group with an effectively managed, large data storage capacity server (100 TB) that enables intensive bioinformatics data analysis by many researchers (72 CPU cores, 768 GB RAM), with high-speed (10 G) network and UPS.

NATIONAL HEART PROGRAMME Research and innovation in the diagnosis and therapy of ischemic heart disease and heart failure

Semmelweis University

Nemzeti Szívprogram

Project code:
NVKP_16-1-2016-0017

Project leader institution:
Semmelweis University

Project leader:
Béla Merkely

Project leader's contacts:
se.kardiologiai.kp.titkarsag@gmail.com

Project partners:
SE; Mediso Kft.;
Pharmahungary 2000 Kft.;
Twinmed Kft.;
Neumann Projekt Kft.

Amount of funding:
HUF 3,299,426,997

RI type: Distributed

Website: http://vszek.semmelweis.hu/nemzeti-szivprogram

Project description:
The project aims to research and develop innovative diagnostic and therapeutic methods, services and products for the reduction of morbidity and mortality of ischemic heart disease and heart failure by establishing interdisciplinary, closely integrated translational RDI platforms (from basic research to epidemiology).

Establishment of cardiology R&D service provider core facilities:
1. molecular and small animal imaging core laboratory; 2. cardiovascular imaging core laboratory; 3. experimental small animal core laboratory; 4. experimental large animal core laboratory; 5. bioinformatics core laboratory; 6. cell technology core-laboratory; 7. histology core laboratory.

The laboratories will offer a cost-efficient and world class infrastructure for the implementation of the programme, and will provide long-term service.
The main task groups of translational research projects, and product and service development projects:

a) Identification and validation of the gene and protein expression pattern of patients' myocardial tissue; the creation of a blood-derived exosome isolation platform; myocardial cell-derived extracellular vesicles biomarkers with multiomic methods.
b) Development of minimally invasive catheter technologies and cardioprotective therapies with modern procedures for effective blood flow restoration, and the development of a new catheter prototype for this.
c) Improvement of the success rate of heart failure resynchronization device therapies and development of a new guideline.
d) Development of automated image analysis and structured reporting software, and exploration of new image information (radiomics) that fit with the national e-Health programme.
e) Development of high-res PET/CT for the examination of animal models.
f) Examination of the epidemiological background of cardiovascular diseases (genotype, phenotype and environment interaction),

Goal: world market sale of products and services developed in the project, and their further development with industrial partners.

Martonvásár Agri-Innovation Centre

HAS Centre for Agricultural Research

Project leader institution:
HAS Centre for Agricultural Research

Project leader:
Ottó Veisz

Project leader's contacts:
veisz.otto@agrar.mta.hu

Development funding:
Prime Minister's Office, NKFIH, MTA, NGM, ERFA

RI type: Single-site

Website:
www.agrar.mta.hu

Project description:
The establishment of a multidisciplinary horizontal research centre that fully exploits the synergies between existing research competencies has been a long-felt need in Hungarian agricultural research. Benefitting from a state-of-the-art laboratory infrastructure, this critical mass of researchers enables internationally outstanding scientific performance and innovations that can be directly taken up by the domestic agricultural sector.

The establishment of such a centre is in progress in Martonvásár. The researchers of the planned Agri-Innovation Centre (AIC) are provided by the scientific staff of the Agricultural Research Centre established in 2012, representing more than 200 professionals from the Agricultural Institute (MGI), Plant Protection Institute (NÖVI) and the Institute for Soil Sciences and Agricultural Chemistry (TAKI). The AIC will operate in the framework of a new research block where NÖVI and TAKI will be located. Due to the multidisciplinarity of the three interdependent disciplines located in the campus (soil science, plant protection, plant breeding / agricultural engineering) the joint work will provide better answers for the problems of agricultural stakeholders. The significantly improving research infrastructure, especially the modern instrument platforms (see below) represent a major scientific attraction and their uniqueness will facilitate participation in national and international cooperation projects. The phenotyping platform enables more efficient and quicker plant feeding and breeding research, resulting in a substantial increase in RDI potential. All instrument platforms have been selected in view of the current scientific trends to ensure that the highly valuable assets will preserve their value for a long time. The platforms are primarily dedicated to research tasks but unused machine time can be sold to industrial and public administration partners, thus contributing to the maintenance of the infrastructure.

Technical description/parameters of the planned research infrastructure:
General laboratory infrastructure accompanied with the following unique platforms: phenotyping platform, genomics and proteomics research platform, metabolic platform (GC/MS/TOF, LC/MS/TOF), imaging platform, field lysimeter and climate manipulating system.

Tandetron Laboratory

MTA Atomki

Project code:
GINOP-2.3.3-15-2016-00005

Project leader institution:
MTA Atomki

Project leader:
György Gyürky

Project leader's contacts:
gyurky@atomki.mta.hu

Amount of funding:
HUF 941,251,475

RI type: Single-site

Website:
http://tandetron.atomki.hu/

Project description:
The infrastructure development funding programme of the Hungarian Academy of Sciences made it possible for MTA Atomki to purchase and in May 2014 to install the Tandetron particle accelerator, manufactured by High Voltage Engineering Europa BV, a Dutch company. In January 2015, we installed the duoplasmatron ion source which generates negative hydrogen ions, the injector magnet, and a simple, temporary switching magnet. According to its operation principle, the Tandetron accelerator generates high-energy positive ion beam (in the present case a proton beam) from negative ions. The simple initial arrangement immediately allowed the implementation of two research beam lines: an external beam setup (allowing to bring the beam out of the vacuum) and an end station for nuclear astrophysics. The first scientific result achieved with the latter setup was presented on a poster at the EuNPC2015 conference in Groningen, the Netherlands, and was awarded the Best Poster Prize. In the meantime, a professional switching magnet was also purchased which enables the connection of 9 beam lines. This system is significantly extended in the framework of the "Creation of a world class research environment in the new Tandetron Laboratory of MTA Atomki" project.

Technical description/parameters of the research infrastructure:
The newly purchased Multicusp ion source and a 90 degree deflection (analyzing) magnet will significantly enhance the capabilities of the accelerator which will thus reach its final form. The dual Multicusp ion source will be suitable for the production of hydrogen and helium ions. The cesium sputtering ion source will enable the generation of negative ions of large mass numbers. The 90-degree analyzing magnet will be placed on the high energy side of the Tandetron. The switching magnet will be installed from its current (temporary) place to the output of the analyzing magnet. The tested nanoprobe will also be moved to a new place: to the right side 10 degree output of the switching magnet. Later, the microprobe will also be moved over here from the old Van de Graaff accelerator, resulting in a much better ion beam quality (in terms of stability, beam size etc.). The new analytical end station will be placed on another output of the switching magnet. The project will enable the development of additional beam lines for present and future internal and external users.

Tandetron

Nano-characterization laboratory for the development of new advanced materials

Instruments Centre, Faculty of Science, Eötvös Loránd University

Project code:
VEKOP-2.3.3.-15-2016-0003

Project leader institution:
Faculty of Science, Eötvös Loránd University

Project leader:
István Groma

Project leader's contacts:
groma@metal.elte.hu

Amount of funding:
HUF 155,595,855

RI type: Single-site

Website:
http://sem.elte.hu

Project description:
Changes in the microstructure of structural materials during use have a decisive impact on their usability. So, it is essential to have a thorough understanding of microstructures for the development of new advanced materials and for the determination of their life cycle. The ELTE TTK microstructure research laboratory features three devices that can determine microstructure at three different scales (atomic, nano and micro).

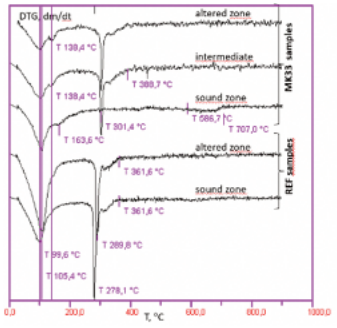
The largest device is unique in Hungary: the FEI Quanta 3D scanning electron microscope has a high-resolution dual beam (SEM/FIB) apparatus. Dual beam means that it has both electron and ion sources. Both beams are suitable for capturing microscopic images but the ion beam makes it possible to manipulate the surface of the sample material at nanoscale. The equipment has several detectors: Secondary electrons have the smallest energy resulting ~1 nm resolution. Backscattered electrons have somewhat higher energy, so they provide information from deeper levels at a resolution of ~2 to 4 nm. The energy of X-ray photons reveal information on their source atom. Therefore, by measuring the energy of the collected X-ray photons, we can analyze the chemical composition of the sample at a certain point or along its surface. The equipment can also operate in transmission mode (STEM) and it is capable to measure electron backscatter diffraction (EBSD) image allowing to determine the local crystalline orientation.

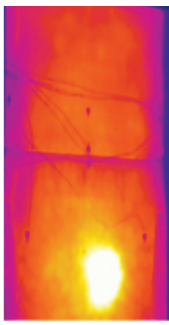
The atomic level structure of surfaces can be imaged by the newly acquired Integrated Scanning Tools for HORIBA Advanced Nano-Technology SmartSPM SPMTM-1000, which works in non-contact AFM, contact AFM, Kelvin probe force microscopy, Piezo response force microscopy, STM, magnetic force microscopy and shear force microscopy modes and it is suitable for nanolithography.

The RIGAKU SmartLab X-ray diffractometer purchased in the same project is equipped with a highly advanced detector and control unit. It enables traditional powder diffraction measurements for determining the phases present in the sample, as well as the determination of texture by inserting a moving/rotating table. It also makes possible to perform X-ray line profile measurements for the direct determination of several microstructure parameters (particle size, dislocation density etc.).

Materials science and experimental development of high-resistance concrete products

Budapest University of Technology and Economics, Department of Construction Materials and Technologies





Project code:
NVKP_16-1-2016-0019

Project leader institution:
Budapest University of Technology and Economics, Department of Construction Materials and Technologies

Project leader:
György Balázs L.

Project leader's contacts:
balazs@vbt.bme.hu

Project partners:
ÉMI Nonprofit Kft.; MC-Bauchemie Építőanyagipari és Kereskedelmi Kft.; CRH Magyarország Kft.; SW Umwelttechnik Magyarország Építőelemgyár Kft.

Amount of funding:
HUF 573,362,862

Website:
http://epito.bme.hu/epitoanyagok-es-magasepites-tanszek

Project description:
The primary goal of the project is to develop experimentally concrete compositions and create concrete products that are more resistant than conventional concrete to 1) aggressive chemical environments (pH <5); 2) high temperature (fire, internal fire or facade fire); and 3) frost. These expectations require different materials science approaches.

The test method comprises of first thoroughly understanding the deterioration processes triggered by physical-chemical-biological effects and then developing experimentally how to slow down or prevent deterioration.

Concrete is a multi-component material system whose behaviour (strength, durability and other properties) is largely determined by the properties of its components. Nevertheless, our studies also focus on a wide range of concretes, admixtures (silica powder, metakaoline, slag, fly ash) and mixed concrete containing them.

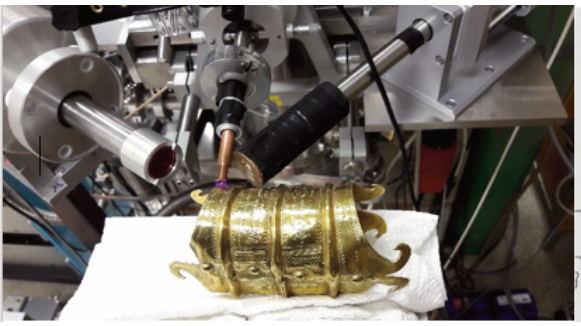
Resistance to aggressive chemical environments, high temperatures or freeze-thaw cycles in winter requires different material composition, structure and technology. The results of the planned tasks are absolutely necessary for ensuring proper resistance against the above-described effects. The experimental concrete compositions are tested both in structural elements and prototypes. Studying the performance of complex systems (reinforced / prestressed concrete structural elements) is also indispensable because of the effect of size.

In the framework of the project, the development of the research infrastructure project is performed by the Budapest University of Technology and Economics as consortium leader, and ÉMI Nonprofit Kft, SW Umwelttechnik Hungary Ltd., CRH Hungary Ltd. as well as MC-Bauchemie Hungary Ltd.as consortium members.

Technical description/parameters of the research infrastructure:
The test equipment for destructive and non-destructive testing of materials; material structure diagnostics; extreme loads effects (fire, frost, acids); application of SEM, CT to engineering tasks.

Construction of the MTA Atomki Heritage Science Laboratory

HAS Institute for Nuclear Research



Project code:
GINOP_23315_2016_00029

Project leader institution:
HAS Institute for Nuclear Research

Project leader:
Zita Szikszai

Project leader's contacts:
szikszai@atomki.mta.hu

Project partners:
MTA Wigner FK; MTA EK; Hungarian National Museum

Amount of funding:
HUF 421,866,241

RI type: Single-site

Website:
http://hslab.atomki.hu/;
http://e-rihs.eu

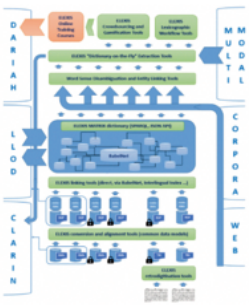
Project description:
"Heritage science" is a relatively new term for the complex research on our cultural and natural heritage, including treatment, conservation, interpretation and documentation. In addition to archaeology, museology, art history, anthropology and palaeontology this field is increasingly dominated by analytical methods, including especially the almost non-destructive, physical procedures and their development. The institution has several decades of traditions in this field, similarly to radiocarbon dating. Heritage science is a dynamically developing area. The ESFRI Roadmap took up the European Research Infrastructure for Heritage Science (E-RIHS) initiative in March 2016, which unites high-quality European analytical equipment, laboratories and museums to create a unique pan-European research infrastructure for research in heritage science. In the preparatory phase Hungary is represented by the E-RIHS consortium (MTA Atomki; MTA Wigner FK; MTA EK, Hungarian National Museum).
Presently, material testing in the institution mainly uses accelerator based ion-beam techniques to determine the elements in the examined materials and their distribution. With the new analytical-imaging devices purchased in the framework of the GINOP programme, a world-class, complex instrument park will be created which enables more complex examinations in a wide range of scales. The new graphitising unit purchased for accelerator mass spectrometry (AMS) enables even more reproducible dating which can be extended to the examination of cremation burials with carbon exploration. The planned introduction of the stable isotope analysis of bones represents the latest trends in modern research, opening up the way to the examination of past eating habits.

Technical description/parameters of the research infrastructure:
Accelerator and analytical beam ends around it, X-ray spectrometry (micro-XRF), 3D digital microscope, electron microscope which does not require high vacuum with additional analytical possibilities (e.g. Raman), AMS C-14, graphitiser, element analyser, infrared and UV spectroscopy, ICP-MS.

HSLab

ELEXIS – European Lexicographic Infrastructure

HAS Research Institute for Linguistics



Project code:
H2020-EU.1.4.1.2., No 731015

Project leader institution:
HAS Research Institute for Linguistics

Project leader:
Tamás Váradi

Project leader's contacts:
varadi.tamas@nytud.mta.hu

Amount of funding:
EUR 130,895

RI type: network distributed

Website:
http://www.elex.is/

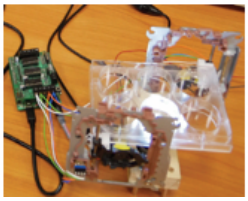
Project description:
The ELEXIS project was launched in 2018 with the participation of 17 European institutions. Hungary is represented by the MTA Research Institute for Linguistics. The project primarily aims to integrate, expand and harmonise national and regional works relating to modern and historical lexicography. The goal is to establish a sustainable infrastructure which, on the one hand, provides effective access to lexical data in the digital age, and on the other hand, compensates for the differences between research communities with varying lexicographical resources.
Furthermore, it is also a priority for ELEXIS to give a major boost to the culture of open access in lexicography, in line with the European Commission's recommendation.

The MTA Research Institute for Linguistics primarily contributes to the project by providing lexicographic data and knowledge and digital linguistic background.

Technical description/parameters of the research infrastructure:
The ELEXIS electronic lexicographic infrastructure is a network infrastructure currently shared by EU member states, and aims to become the standard cross-linguistic distributed infrastructure of lexicographic data. Its goal is to achieve the fullest possible interoperability between the dictionaries of the participating member states. The infrastructure also relies on the hardware and software infrastructure of leading lexicographic centres, including especially Sketchengine, a corpus handling and dictionary editing framework program.

The Internet of Living Things

University of Szeged



Consortium leader:
Project code:
GINOP-2.2.1-15-2017-00073

Project leader institution:
University of Szeged

Project leader:
Tibor Gyimóthy

Project leader's contacts:
gyimi@inf.u-szeged.hu

Project partner:
MTA Biological Research Centre in Szeged

Amount of funding:
HUF 810,986,542

Website:
https://www.u-szeged.hu/fejlesztesiprojektek/ginop-2-3-2-15-2016-170525/ginop-2-3-2-15-2016

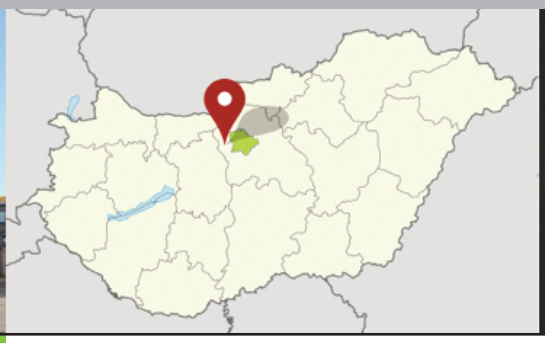
Project description:
By establishing the IoLT research group our aim is to create a platform based on our former R&D results that will facilitate the development of IoLT applications through the high-level programming of ultra-low-resource sensors for adaptive data collection and processing. The platform is open source, so it will potentially attract special attention and have a major role in international projects.

The resulting IoLT (Internet of Living Things) research group constitutes a novelty even at international level, as it integrates research in IoT basic technologies and areas of biological and medical applications. The goal is to develop an integrated IoLT research group, in which the participating researchers and international research teams involved through their relationships build up a knowledge base of excellence. Based on the results of previous international industrial cooperation, the project will establish an open source IoLT platform that allows even non-IT researchers to develop biological, medical, and other IoT applications. The platform will work on ultra-low-resource, ultra-cheap IoT devices as well. To this end, we are engaging in R&D in international cooperation in the following areas: JavaScript execution engine, IoT development environment, device drivers, communications, IoT cloud infrastructure, algorithms for data safety and security.

Within IoLT the focus is on biological and medical applications. The "Smart Pot" sub-project is dedicated to the examination of the impact of environmental factors determining the growth and stress reactions of individual plants. Our actigraphic research is aimed at identifying new ultradian and slower periodic and stochastic components in human physical activity patterns and at establishing their correlation to physical conditions, activities, and certain psychiatric disorders. The applicability of the results will be tested in medical practice. The development of "Lab-on-a-chip" systems greatly increases the effectiveness of work on cell cultures. This facilitates the high throughput testing of potential active substances. To increase the efficiency of personalised therapies we develop image processing and machine learning algorithms for the analysis of microscopic images and the determination of automatic classification planned to be implemented with feature extraction methods based on local and cell neighbourhood.

Wigner DC – Wigner Data Centre

HAS Wigner Research Centre for Physics



Project code:
ED_12-1-2012-0003

Project leader institution:
HAS Wigner Research Centre for Physics

Project leader:
Gábor Pető

Project leader's contacts:
peto.gabor@wigner.mta.hu

Amount of funding:
HUF 8,500,000,000

RI type: Single-site

Website:
https://wigner.mta.hu/wignerdc

Project description:
Wigner Datacenter (WDC) is the most advanced, leading IT research infrastructure in both Hungary and Central Europe. It was constructed in 2013 within the boundaries of MTA Wigner Research Centre for Physics, in Csillebérc, Budapest.
Currently the main purpose of WDC is to provide the technical background for processing and storing data coming from the CERN accelerator, pursuing its research programmes in the field of particle physics, with special emphasis on the experiments of ESFRI Landmark High-Luminosity LHC (HL-LHC) programme (ALICE, ATLAS, CMS, LHCb). The computers set up in WDC, part of CERN's TIER-0 site, are being used by more than 10,000 users.
Building on the experience gained by providing these services for CERN, WDC staff launched the (Wigner) WDC Cloud after careful planning in 2015, followed by the (Academic) MTA Cloud created in collaboration with MTA SZTAKI, one year later. (Part of the MTA Cloud is run by MTA SZTAKI). These Academic Clouds are capable of supporting and fulfilling the IT related needs of domestic and regional research at an international standard, such as the National Brain Research Programme, National Quantum Technology Programme, ELI, VIRGO, and other CERN and H2020 projects.
The MTA and WDC Clouds operating in WDC support more than 1,000 thousand potential users from the fields of particle physics, gravity research, artificial and intelligent materials, neuroscience, bioinformatics, medical research, social sciences, and computational sciences.

Technical description/parameters of the research infrastructure:
The Wigner Datacenter has been housing – during the past 5 years – an ever growing number of computers purchased by CERN. Currently 80,000 CPU cores (corresponding to 140,000 virtual cores) and 80 PB of disk space supports the research experiments of HL-LHC.
The MTA Cloud and the WDC Cloud, run in WDC, have a combined capacity of 2,500 CPU cores (5,000 virtual cores) and 2 PB of disk space, along with a 1.6 PB tape drive in support of both Hungarian and other researchers from the region. In 2018 the integrated GPU service has been launched. The 8 NVIDIA Tesla V100 units have a total combined performance of 62 Teraflop for double-precision calculations and 1 Petaflop for tensor calculations.
There is also a CERN TIER-2 station operating in the Wigner Research Centre for Physics, Research Institute for Particle and Nuclear Physics (MTA Wigner FK RMI) with 1,000 CPU cores (2,000 virtual cores, total power: approx. 15,000 HS06) and 1 PB storage capacity, and a GPU Laboratory (0.1 Petaflop) as an educational and research centre. HL-LHC data collection activities are also supported by the RMI DAQ Data Collection Development Laboratories and the RMI Innovative Detectors Laboratory.

9. List of abbreviations

ACTRIS	Aerosols, Clouds and Trace gases Research Infrastructure
AHEAD	Advanced Hybrid Engines for Aircraft Development
ASTERICS	Astronomy ESFRI & Research Infrastructure Cluster
BBMRI- ERIC	Biobanking and BioMolecular resources Research Infrastructure European Research Infrastructure Consortium
BCE	Corvinus University of Budapest
BKR	Budapest Research Reactor
BME	Budapest University of Technology and Economics
BME EGR	BME Department of Energy Engineering
BME MOKK	BME Centre for Media Research and Education
BME NTI	BME Institute of Nuclear Techniques
BME TMIT	BME Department of Telecommunications and Media Informatics
BME VET	BME Department of Electric Power Engineering
BNC	Budapest Neutron Centre
DE	University of Debrecen
DE TTK	DE Faculty of Science and Technology
EGO ERIC	European Gravitational Observatory Research Infrastructure Consortium
ELTE	Eötvös Loránd University
ERINHA	European research infrastructure on highly pathogenic agents
EST	European Solar Telescope
EU-OPENSCREEN	European Infrastructure of Open Screening Platforms for Chemical Biology
FAIR	Facility for Antiproton and Ion Research
GINOP	Economic Development and Innovation Operational Programme (EDIOP)
H2020	EU Framework Programme for Research and Innovation
JRC ISPRA	Joint Research Centre
IAEA	International Atomic Energy Agency
ICOS ERIC	Integrated Carbon Observation System European Research Infrastructure Consortium
IKT	information and communications technology (ICT);
ILL	Institut Laue-Langevin
INSTRUCT	Integrated Structural Biology Infrastructure
KE	University of Kaposvár
RDI	Research, development and innovation
KSH	Hungarian Central Statistical Office
LifeWatch	E-infrastructure for Biodiversity and Ecosystem Research
ME	University of Miskolc
ME GIK	ME Faculty of Mechanical Engineering and Information Technology
MME	Hungarian Ornithological and Nature Conservation Society
HAS	Hungarian Academy of Sciences
MTA ATK	HAS Centre for Agricultural Research
MTA Atomki	HAS Institute for Nuclear Research
MTA CSFK	HAS Research Centre for Astronomy and Earth Sciences
MTA CSFK CSI	HAS Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Research Centre for Astronomy and Earth Sciences

MTA CSFK GGI	HAS Research Centre for Astronomy and Earth Sciences, Geodetic and Geophysical Institute
MTA CSFK FGI	HAS Research Centre for Astronomy and Earth Sciences, Institute for Geological and Geochemical Research
MTA CSFK FTI	HAS Research Centre for Astronomy and Earth Sciences, Geographical Institute
MTA EK	HAS Centre for Energy Research
MTA EK AEKI	HAS Centre for Energy Research, Atomic Energy Research Institute
MTA EK EKBI	HAS Centre for Energy Research, Institute for Energy Security and Environmental Safety
MTA EK MFA	HAS Centre for Energy Research, Institute of Technical Physics and Materials Science
MTA KOKI	HAS Institute of Experimental Medicine
MTA KRTK	HAS Centre for Economic and Regional Studies
MTA ÖK	HAS Centre for Ecological Research
MTA RAMKI	HAS Alfréd Rényi Institute of Mathematics
MTA SZBK	HAS Biological Research Centre in Szeged
MTA SZTAKI	HAS Institute for Computer Science and Control
MTA TK	HAS Centre for Social Sciences
MTA TTK AKI	HAS Research Centre for Natural Sciences
MTA Wigner FK	HAS Wigner Research Centre for Physics
MTA Wigner FK RMI	HAS Wigner Research Centre for Physics, Research Institute for Particle and Nuclear Physics
MYRRHA	Multi-purpose hYbrid Research Reactor for High-tech Applications
NAIK	National Agricultural Research and Innovation Centre
NOAA	National Oceanic and Atmospheric Administration
OMSZ	Hungarian Meteorological Service
OPTICON	Optical Infrared Coordination Network for Astronomy
PE	University of Pannonia
PPKE	Pázmány Péter Catholic University
PRACE	Partnership for Advanced Computing in Europe
PSE	physical sciences and engineering
PTE	University of Pécs
SE	Semmelweis University
S3	Smart Specialisation Strategy
SE EMKI	SE Faculty of Forestry, Institute of Forest Engineering and Environmental Technology
SZE	Széchenyi István University
SZIE	Szent István University
SZTE	University of Szeged
STEM	Science, Technology, Engineering and Mathematics
VEKOP	Competitive Central Hungary Operational Programme (CCHOP)

10. Contributors

Members of the National Research Infrastructure Committee

Zsolt Fülöp, president, HAS Institute for Nuclear Research
György Miklós Keserű, HAS Research Centre for Natural Sciences
Gábor Kovács L., University of Pécs, Szentágothai Research Centre
Zoltán Marczinkó, Ministry of National Economy, State Secretariat for Economic Development and Regulation
László Patthy, HAS Research Centre for Natural Sciences, Institute of Enzymology
András Perczel, Eötvös Loránd University, Faculty of Science, Institute of Chemistry
Gábor Prószéky, HAS Research Institute for Linguistics
Tamás Rudas, HAS Centre for Social Sciences
István Szabó, Ministry of Human Capacities, Department for Higher Education and Research Strategy

Members of the National Research Infrastructure Committee with right of consultation
Gyula Faigel, HAS Wigner Research Centre for Physics
Péter Lévai, HAS Wigner Research Centre for Physics

External experts

Tamás Belgya, HAS Centre for Energy Research
György Balázs L., Budapest University of Technology and Economics, Faculty of Architecture
András Edelmayer, HAS Institute for Computer Science and Control
András Gelencsér, University of Pannonia
István Groma, Eötvös Loránd University
Tibor Gyimóthy, University of Szeged
György Gyürky, HAS Institute for Nuclear Research
Imre Kacskovics, Eötvös Loránd University, Faculty of Science, Institute of Biology
Béla Merkely, Semmelweis University, Városmajor Heart and Vascular Center
László Szarka, HAS Research Centre for Astronomy and Earth Sciences
Zita Szikszai, HAS Institute for Nuclear Research
János Tamás, University of Debrecen, Faculty of Agricultural and Food Sciences and Environmental Management
József Tőzsér, University of Debrecen
Tamás Váradi, HAS Research Institute for Linguistics
Ottó Veisz, HAS Centre for Agricultural Research, Agricultural Institute
Gyula Záray, Eötvös Loránd University