



NATIONAL RESEARCH, DEVELOPMENT AND INNOVATION OFFICE  
HUNGARY

# RESEARCH INFRASTRUCTURES FOR EXCELLENCE IN HUNGARY





*A foreword by*

**István Szabó PhD,**

vice president for science and international affairs, NRDIO

The competitiveness of any country greatly depends on how efficiently it can use opportunities unearthed by scientific and technological innovation. Along with our internationally acclaimed educational and research institutions, domestic research infrastructures are key in this multifaceted struggle for excellence. Not only these research infrastructures (RI's) provide the essential foundation for fundamental and exploratory research, but they also exert a significant impact both on a social and an economical level. Having focused on RI's as a researcher

has taught me that the more access to world-class infrastructures a country has the better, as it can cope with challenges on the long run. In this respect I can proudly say that Hungary has a lot to offer.

Hungary's participation in internationally outstanding research infrastructures creates a number of opportunities for domestic researchers to shape and enhance their professional development, supports their affiliation with international research networks and encourages the formation of multidisciplinary collaborations. In order to widen and enhance co-operation on all levels, the National Research, Development and Innovation Office (NRDIO) have joined a number of international research infrastructures in recent years, thus providing direct access for local professionals in research and development to the circulation of international science and innovation.

Research infrastructures are key in the realization of R+D+I co-operations within the ever-widening network of, among many others, higher education institutions, academic research facilities, state-run nonprofit research organizations, centres of research and technology and businesses of all sizes. With the correct strategy, the interoperability of academic- and industry players will become the propelling force underlying the country's economic growth.

With the simplest approach, the primary role of research infrastructures is the continuous and efficient production of knowledge, so that excellence, wherever possible, is achieved, making our lives better. However, all this requires ever-expanding co-operation with transborder research infrastructures, intensive networking between the various research facilities and the continuous development of the infrastructures. Hereby I invite all international researchers to take a look or two at the main research infrastructures in Hungary and find your next stop in R+D+I. Because like I said above, in research and development our country has a lot to offer.

# RESEARCH AND DEVELOPMENT IN HUNGARY: WE HAVE A LOT TO OFFER



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 ENERGY

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INNOVATION

 DATA, COMPUTING  
AND DIGITAL RIS



# INTRODUCTION

A distinguished area of international scientific cooperation relies on research infrastructures (RI), as scientific platforms. Research infrastructures are essential to build dedicated frameworks that provide great opportunities for researchers to develop their professional skills, to join international networks and foster multidisciplinary collaborations. Therefore, they give the backbone of national and international knowledge communities, serving as strategic tools in the development of research and innovation.

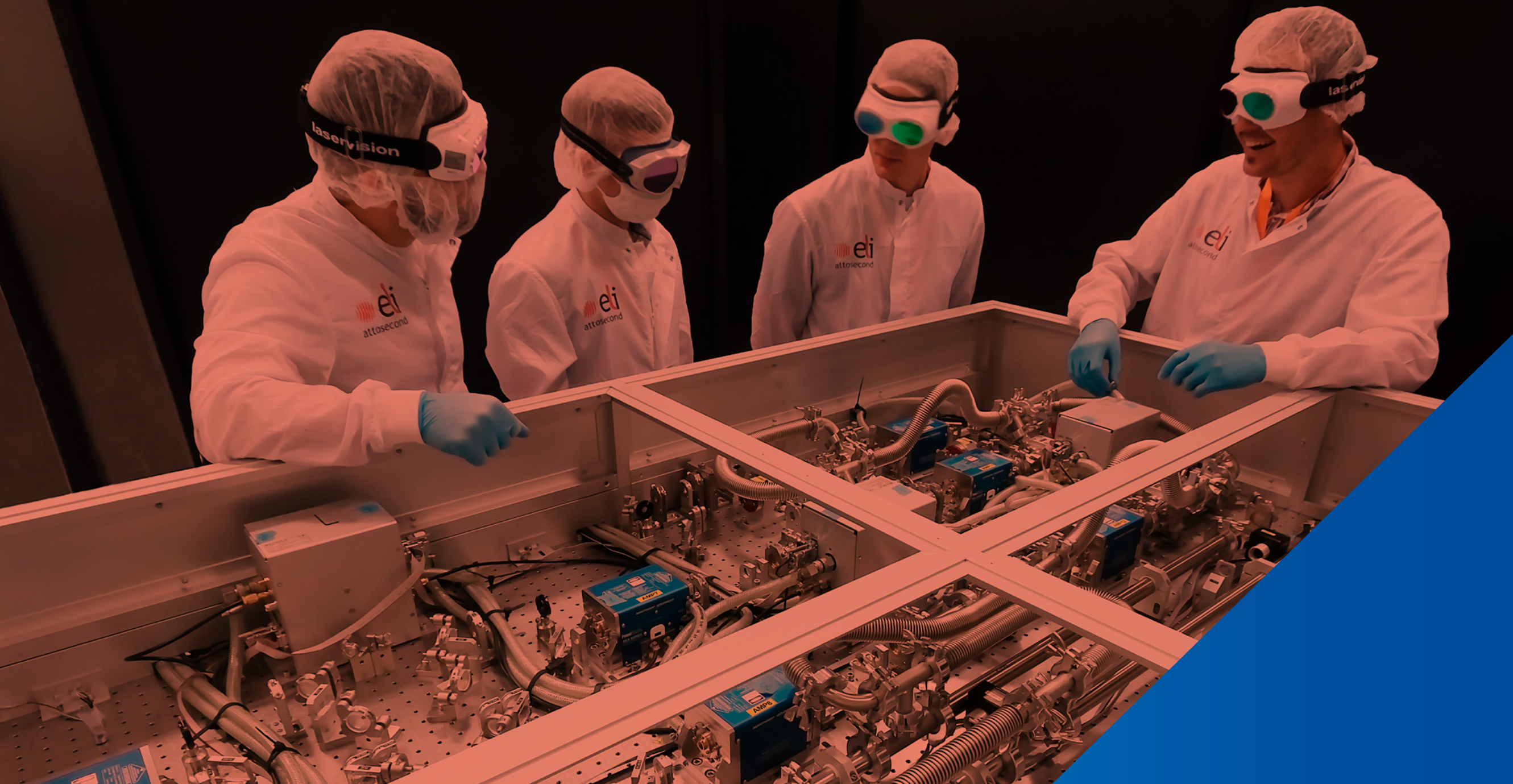
Hungary, through the National Research, Development and Innovation Office (NRDI Office) has joined several international research infrastructures (see <https://nkfih.gov.hu/nemzet-kutatasi-infrastruktura-utiter>) in recent years to enhance our international cooperation. The NRDI Office spends more than 10 million EUR annually on membership fees associated with our participation in international research infrastructures and organizations. While improving excellence in science is our main goal, an equally important aspect and aim of our contribution is to enhance the economic advantages of our membership by increasing the share of in-kind contributions.

Hungary participates in 16 projects and landmarks included in the latest Roadmap 2018 of the European Strategy Forum on Research Infrastructures (ESFRI). In addition, Hungary participates in several non-ESFRI related research infrastructures (e.g. CERN, EMBL, ICGEB, etc.) where Hungarian researchers can also benefit from our membership. Among the ESFRI RIs, the Extreme Light Infrastructure (ELI) project has a significant importance for us, since the ELI-Attosecond Light Pulse Source (ELI-ALPS) next generation laser facility has been built in Hungary and it is an integral part of the pan-European RI landscape. The Extreme Light Infrastructure is the first infrastructure in the world capable of investigating the interactions between light and matter with the highest intensity, in the so-called ultra-relativistic range. It will open a doorway into new territories of science and will have a considerable impact on numerous fields of material science, medicine and environment protection.

It is an important goal for us to enable Hungarian researchers to get into the stream of the research provided by the international research infrastructures as efficiently as possible, therefore in 2019 we have introduced a new call for proposal, under which researchers can apply for support to their travel and stay at the host institution and also the dissemination costs of their research results can be covered.

In connection with the update of the ESFRI Roadmap 2018 planned for 2021 by the ESFRI Forum, we assessed in a nationwide survey which fields the Hungarian researcher community would have an interest to join the ESFRI Roadmap 2018 Projects and Landmarks. As a result of the survey, Hungary is expected to join more international research infrastructures effective from 2021, which we include in our present summary.





# HUNGARY'S MEMBERSHIPS IN EUROPEAN RESEARCH INFRASTRUCTURES



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RI short name	RI name	ESFRI Landmark/ Project	Start of participation (year)	Brief description
BBMRI ERIC	Biobanking and BioMolecular Resources Research Infrastructure - European Research Infrastructure Consortium	Landmark	2021	The biobanking research infrastructure brings together all the main players from the biobanking field – researchers, biobankers, industry, and patients – to boost biomedical research. The ultimate goal is to make new treatments possible.
ECRIN ERIC	European Clinical Research Infrastructure Network - European Research Infrastructure Consortium	Landmark	2017	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	European Life-sciences Infrastructure for Biological Information	Landmark	2016	The European initiative connects and integrates into a single infrastructure the major bioinformatics resources of national centres, hubs and service providers. It supports many fields of life sciences, including research in the field of agriculture and medicine.
EMBL	European Molecular Biology Laboratory	Not ESFRI related	2017	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	Landmark	2018	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 - European Research Infrastructure Consortium	Landmark	2016	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 ESFRI related	1987	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.





RI short name	RI name	ESFRI Landmark/ Project	Start of participation (year)	Brief description
CERIC-ERIC	Central European Research Infrastructure Consortium - European Research Infrastructure Consortium	Not ESFRI related	2017	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 (ALICE, CMS)	The European Organization for Nuclear Research	Not ESFRI related	1992	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.
CERN HL-LHC	High-Luminosity Large Hadron Collider	Landmark	2014	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	Extreme Light Infrastructure	Landmark	2013	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 EBS	European Synchrotron Radiation Facility Extremely Brilliant Source	Landmark	2017	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.





RI short name	RI name	ESFRI Landmark/ Project	Start of participation (year)	Brief description
ESS ERIC	European Spallation Source - European Research Infrastructure Consortium	Landmark	2014	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	2009	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 ESFRI related	2007	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.





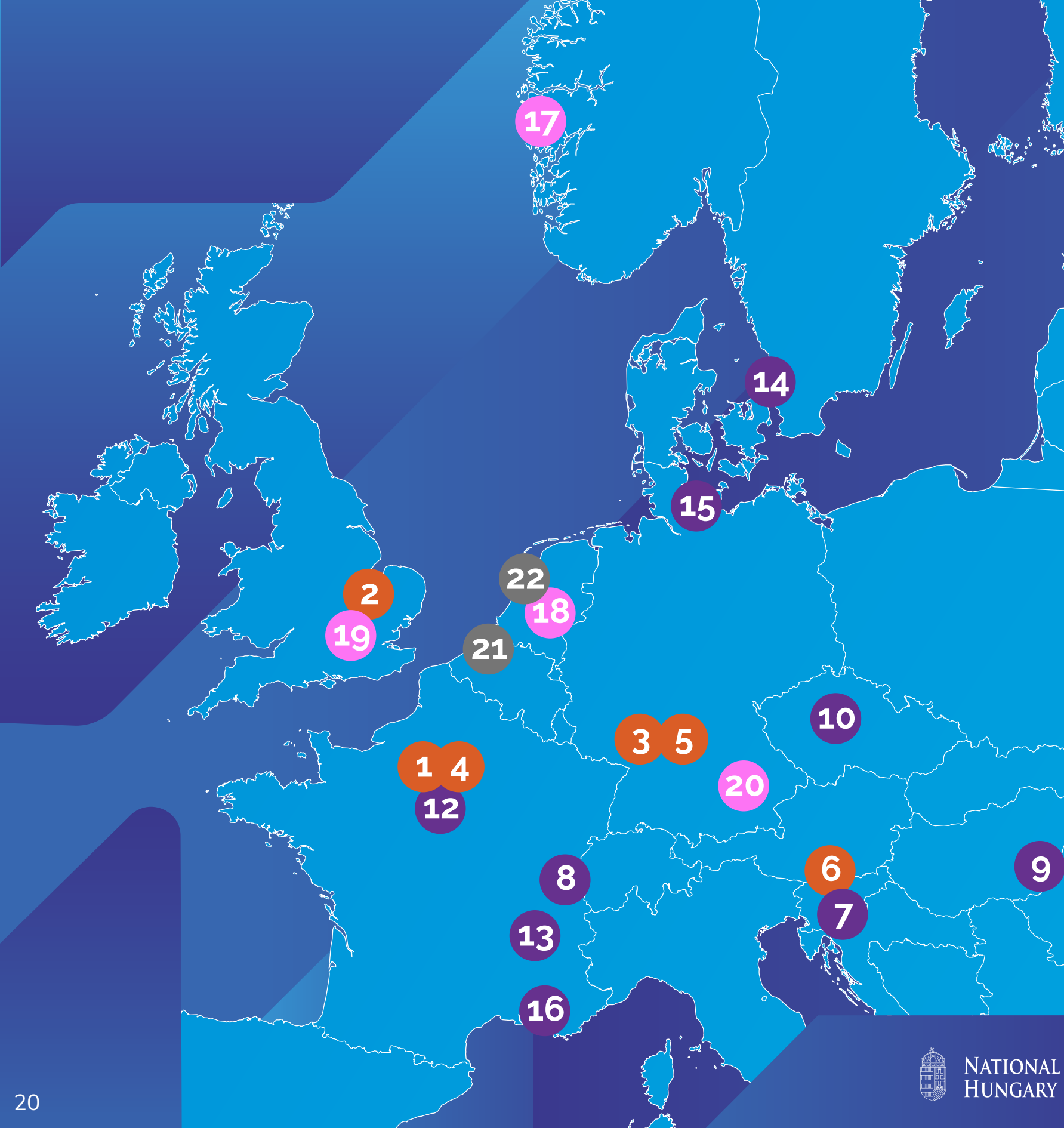
RI short name	RI name	ESFRI Landmark/ Project	Start of participation (year)	Brief description
CESSDA ERIC	Consortium of European Social Science Data Archives - European Research Infrastructure Consortium	Landmark	2017	The only virtual research infrastructures which provides a single interface to the 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 Infrastructure - European Research Infrastructure Consortium	Landmark	2016	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.
E-RIHS	European Research Infrastructure for Heritage Science	PROJECT	2021	Supports research on heritage interpretation, preservation, documentation and management, in order to deliver integrated access to expertise, data and technologies through a standardized approach, and to integrate world-leading European facilities into an organisation.
ESS ERIC	European Social Survey - European Research Infrastructure Consortium	Landmark	2016	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	2017	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.





RI short name	RI name	ESFRI Landmark/ Project	Start of participation (year)	Brief description
PRACE	Partnership for Advanced Computing in Europe	Landmark	2012	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 ESFRI related	1993	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.





- 1 ECRIN-ERIC – Paris, France
- 2 ELIXIR – Hinxton, United Kingdom
- 3 EMBL – Heidelberg, Germany
- 4 ERINHA – Paris, France
- 5 EuBi ERIC – Heidelberg, Germany
- 6 ICGEB – Trieste, Italy
- 7 CERIC-ERIC – Trieste, Italy
- 8 CERN – Geneva, Switzerland
- 9 ELI ERIC – Szeged, Hungary
- 10 ELI ERIC – Prague, Czech Republic
- 11 ELI ERIC – Bucharest, Romania
- 12 ESA – Paris, France
- 13 ESRF – Grenoble, France
- 14 ESS ERIC Spallation – Lund, Sweden
- 15 European XFEL – Schenefeld, Germany
- 16 ITER – Saint-Paul-lès-Durance, France
- 17 CESSDA ERIC – Bergen, Norway
- 18 CLARIN ERIC – Utrecht, The Netherlands
- 19 European Social Survey ESS – London, United Kingdom
- 20 SHARE ERIC – München, Germany
- 21 PRACE – Ixelles, Belgium
- 22 GEANT – Amsterdam, The Netherlands



# RESEARCH INFRASTRUCTURES OVERVIEW



NATIONAL RESEARCH, DEVELOPMENT AND INNOVATION OFFICE  
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# INTRODUCTION TO RESEARCH INFRASTRUCTURES

One of the key factors in achieving the goals set by a National RDI Strategy is the level of development of the domestic research infrastructures and their embeddedness in the international RI landscape. Therefore investing in RIs is a cornerstone of our national research policy.

RIs have to be viewed as an integral part of a broader ecosystem contributing to the longer-term development of research and innovation and enablers to reduce the „excellence gap“. The bridging role of research infrastructures in RDI collaborations and economic development is enhanced by the synergic planning and implementation of different funding sources. The development and networking of research infrastructures in Hungary has been supported by a number of schemes in the past. These have made it possible to expand and update our existing RI capacities and to improve their services for research and innovation.

The services provided by research infrastructures to enterprises, SMEs and other actors of the industry can contribute to the development of new technologies, products and services that can have a positive impact on the economy. Unique and cutting-edge scientific facilities can also enhance the mobility of researchers, they have an impact on education and play an important role in the scientific orientation and training of the next generation of scientists. Besides, research infrastructures can serve as tools for implementing 'open laboratory' initiatives and play an important role in the promotion of 'open innovation' efforts.

Through the implementation of the Smart Specialisation Strategy (S3) the research infrastructures will play a key role in the economic development of the regions and will be important factors of our next programming period as well. Their use can greatly enhance cross-border regional and international RDI cooperation.

In this publication we present our national research infrastructures and laboratories of international significance to the broad international research community, which are of key importance in a particular field, provide international research opportunities, contribute to solving strategically important problems, carry out significant research at international level and are actively involved in initiatives and collaborations at European level.



RI name	Name of coordinator institution	RI site	Region	International RI connection
Budapesti Neutron Centrum (BNC)	Centre for Energy Research	Budapest	Budapest	CERIC-ERIC, ESS-ERIC, ILL, Joint Institute for Nuclear Research (JINR)
FIEK MVM Smart Power Laboratory	Budapest University of Technology and Economics (BME), Center for University-Industry Cooperation (FIEK)	Budapest	Budapest	-
Modular Hybrid Drive System Laboratory	Budapest University of Technology and Economics (BME), Center for University-Industry Cooperation (FIEK)	Budapest	Budapest	-



RI name	Name of coordinator institution	RI site	Region	International RI connection
Isotope Climatology and Environmental Research Centre (ICER)	Institute for Nuclear Research	Debrecen	Northern Great Plain	-
3DLab - Infrastructure for Fine and Structure Analysis	University of Miskolc	Miskolc	Northern Hungary	CERN
International territorial water management and climate adaptation instruments centre	University of Debrecen	Debrecen	Northern Great Plain	-





RI name	Name of coordinator institution	RI site	Region	International RI connection
Biosafety Level-4 Laboratory at University of Pécs (BSL-4)	University of Pécs, Szentágothai Research Centre (UP-SRC)	Pécs	Southern Transdanubia	ERINHA
Biobank Network	Semmelweis University	Budapest	Budapest	BBMRI
Bioanalytical instrumentation for analyte examination at molecular and cellular levels	University of Debrecen	Debrecen	Northern Great Plain	ELIXIR, Euro BioImaging
Integrated Infrastructure for Molecular Science and Molecular Medicine (I2M2)	University of Debrecen	Debrecen	Northern Great Plain	INSTRUCT





RI name	Name of coordinator institution	RI site	Region	International RI connection
ELIXIR Hungary (ELIXIR-HU)	Research Centre for Natural Sciences	Budapest	Budapest	ELIXIR, EMBL
Hungarian European Clinical Research Infrastructura Network (HECRIN)	University of Pécs, Szentágothai Research Centre (UP-SRC)	Pécs	Southern Transdanubia	ECRIN ERIC
BiImaging Hungary	University of Debrecen	Debrecen	Northern Great Plain	EuBI ERIC





RI name	Name of coordinator institution	RI site	Region	International RI connection
Extreme Light Infrastructure Attosecond Light Pulse Source (ELI-ALPS)	ELI-HU Non-Profit Ltd.	Szeged	Southern Great Plain	ELI ERIC
ZalaZONE Automotive Proving Ground	Automotive Proving Ground Ltd.	Zalaegerszeg	Western Transdanubia	-
Atomki Tandetron Laboratory (ATL)	Institute for Nuclear Research	Debrecen	Northern Great Plain	CERN, E-RISH, IPERION-HS
Functional Materials Laboratory (FunMatLab)	Wigner Research Centre for Physics	Budapest	Budapest	ESRF, EU-XFEL, SwissFEL, ELI-Beamlines



RI name	Name of coordinator institution	RI site	Region	International RI connection
Nanolab (Electron Microscopy) at the University of Pannonia	University of Pannonia	Veszprém	Central Transdanubia	-
Aberration corrected transmission electron microscope	Centre for Energy Research	Budapest	Budapest	-
Micro- and Nanotechnology Research Laboratory	Centre for Energy Research	Budapest	Budapest	-
Cyber Physical Pilot Production System	Institute for Computer Science and Control	Budapest	Budapest	-
Autonomous Vehicles Research Centre (AVRC)	Institute for Computer Science and Control	Budapest	Budapest	-
Machine Vision and Optical Perception Laboratory	Institute for Computer Science and Control	Budapest	Budapest	-





RI name	Name of coordinator institution	RI site	Region	International RI connection
Atomki Laboratory for Heritage Science (HSLab)	Institute for Nuclear Research	Debrecen	Northern Great Plain	E-RISH, IPERION-HS
HUNCLARIN	Research Institute for Linguistics	Budapest	Budapest	CLARIN ERIC



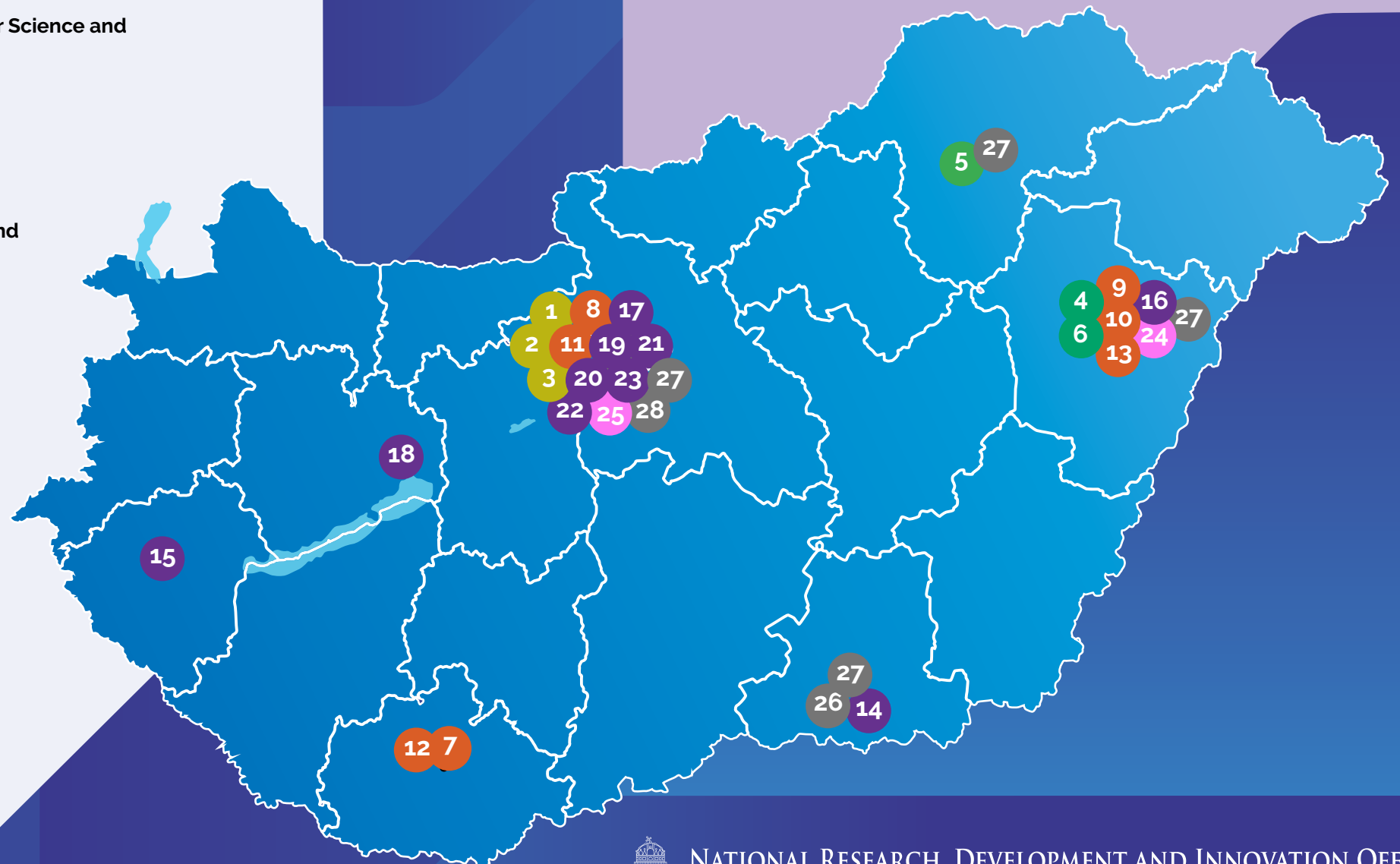


RI name	Name of coordinator institution	RI site	Region	International RI connection
Internet of Living Things (IoLT)	University of Szeged	Szeged	Southern Great Plain	ELI ALPS
Hungarian National Supercomputing Service and Competence Centre	Governmental Agency for IT Development	Debrecen, Miskolc, Szeged, Budapest	Northern Great Plain, Northern Hungary, Southern Great Plain, Budapest	GEANT, PRACE, EOSC
Wigner Data Center	Wigner Research Centre for Physics	Budapest	Budapest	CERN



- 1 Budapesti Neutron Centrum (BNC) Budapest
- 2 FIEK MVM Smart Power Laboratory Budapest
- 3 Modular Hybrid Drive System Laboratory Budapest
- 4 Isotope Climatology and Environmental Research Centre (ICER) Debrecen
- 5 3DLab- Infrastructure for Fine and Structure Analysis Miskolc
- 6 International territorial water management and climate adaptation instruments centre Debrecen
- 7 Biosafety Level-4 Laboratory at University of Pécs (BSL-4) Pécs
- 8 Biobank Network Budapest
- 9 Bioanalytical instrumentation for analyte examination at molecular and cellular levels Debrecen
- 10 Integrated Infrastructure for Molecular Science and Molecular Medicine (I2M2) Debrecen
- 11 ELIXIR Hungary (ELIXIR-HU) Budapest
- 12 Hungarian European Clinical Research Infrastructura Network (HECRIN) Pécs
- 13 Bioluminescence Imaging Hungary Debrecen
- 14 Extreme Light Infrastructure Attosecond Light Pulse Source (ELI-ALPS) Szeged
- 15 ZalaZONE Automotive Proving Ground Zalaegerszeg
- 16 Atomki Tandetron Laboratory (ATL) Debrecen
- 17 Functional Materials Laboratory (FunMatLab) Budapest
- 18 Nanolab (Electron Microscopy) at the University of Pannonia Veszprém
- 19 Aberration corrected transmission electron microscope Budapest
- 20 Micro- and Nanotechnology Research Laboratory Budapest
- 21 Cyber Physical Pilot Production System Budapest
- 22 Autonomous Vehicles Research Centre (AVRC) Budapest
- 23 Machine Vision and Optical Perception Laboratory Budapest

- 24 Atomki Laboratory for Heritage Science (HSLab) Debrecen
- 25 HUNCLARIN Budapest
- 26 Internet of Living Things (IoLT) Szeged
- 27 Hungarian National Supercomputing Service and Competence Centre Debrecen, Miskolc, Szeged, Budapest
- 28 Wigner Data Center Budapest





# RESEARCH INFRASTRUCTURES IN HUNGARY



NATIONAL RESEARCH, DEVELOPMENT AND INNOVATION OFFICE  
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# Budapest Neutron Centre



**Host institution:**

Centre for Energy Research (EK),  
Eötvös Loránd Research Network

**RI location:**

Budapest, KFKI campus

**Status:**

Fully operational, 1993-

**Partners:**

Wigner Research Centre for Physics

**International connections:**

RIs: CERIC-ERIC, ESS-ERIC, ILL,  
JINR, 'Kurchatov Institute'

**Research organizations:**

ENSA, ERF-AISBL, LENS; Partners in  
EU projects (H2020 currently: ARIEL,  
Cremlin+, IPERION-HS, E-RIHS,  
TOURR)

**Available services:**

17 neutron instruments at the  
Budapest Research Reactor; related  
expertise, sample preparation labs &  
on-site complementary techniques  
(X-ray and optical spectroscopy,  
electron microscopy, etc.)

**Website:**

<https://www.bnc.hu/>

**Person in charge:**

Ákos Horváth, Director General of EK  
[horvath.akos@energia.mta.hu](mailto:horvath.akos@energia.mta.hu)

**Contact:**

Tamás Belgya, Director of BNC  
[belgya.tamas@energia.mta.hu](mailto:belgya.tamas@energia.mta.hu)

## Description of the research infrastructure

The Budapest Research Reactor (BRR) was commissioned in 1959 and has been operated at 10-MW power with a cold neutron-source since its major reconstruction in 1992. The Budapest Neutron Centre (BNC), a consortium of research institutes was established in 1993 to co-ordinate the utilisation of the reactor. A reorganisation in January 2020 unified all BNC staff and equipment within the EK. BNC is a single-sited, large-scale, international, and multidisciplinary neutron facility based on the Budapest Research Reactor.

A recent Government-provided fund enabled purchasing fresh fuel for the continued operation of BRR. A service life extension programme aims at prolonging its operational license until 2033. In parallel, BNC is about to modernize its existing beamline facilities and install some new unique/world-class instruments, within the National Laboratory initiative of the NRDl Office.

## Activities and services

The Executive Board of BNC coordinates the research activities and assists the EK management in strategy-building, promotion, industrial outreach, with regular support from the International Scientific Advisory Council (ISAC), an independent body consisting of renowned European scientists. An international User Selection Panel (USP) assesses the scientific excellence of experimental proposals submitted twice a year to the RI. The User Office administers the proposals, evaluations, research reports, publications, technically manages user visits and occasional events. The instrument scientists perform the user experiments, carry out own research projects, develop and promote their instrument.

Neutron scattering, spectroscopy, activation and imaging methods can reveal the nano/micro/macro-structure or the composition of materials. BNC offers excellence-based open access to 17 experimental stations within the international user programme, applicable to basic and applied research in physics, materials science, chemistry, health and biology, radiation protection, engineering, and cultural heritage. The RI provides internationally competitive research opportunities for about 200 domestic and over 500 neutron-users in Central-Europe. The results get published in peer-reviewed articles, M.Sc. or Ph.D. theses, grant-related research reports, popular science notes, and in the social media. The RI's methodical and instrumental developments are regularly transferred to SMEs to generate revenue. BNC has been a particularly successful participant of EU research infrastructure programmes, as it was beneficiary of over 20 EU framework projects since FP5 (NMI3, CHARISMA, BrightnESS, etc.) and numerous national and international bilateral projects.

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# FIEK MVM Smart Power Laboratory


**Host institution:**

Budapest University of Technology and Economics (BME), Center for University-Industry Cooperation (FIEK)

**RI location:**

Budapest, BME campus Bldg V1

**Status:**

Fully operational, 2018

**Partners:**

MVM Group, MVM Hungarian Electricity Private Limited Company (MVM Zrt.)

**International connections:**

**RIs:** RWTH Aachen University, Institute for Automation of Complex Power Systems

**Available services:**

PHIL testing, HIL testing, rapid prototyping of controllers, relays in multidomain real time simulation environment. Hybrid simulation of microgrid in island and grid parallel mode. Testing grid support: virtual inertia, island detection and resynchronization. Analyzing PV and storage in voltage control and power sharing, consumers with variable demand, variable power factors, harmonic distortion, asymmetry. Energy management in AC and DC microgrid.

**Website:**

<https://www.fiek.bme.hu/>

**Person in charge:**

László Lengyel, Director of BME FIEK  
lengyel@aut.bme.hu

**Contact:**

Dr. Dávid Raisz, PhD, Head of Smart Power Laboratory,  
raisz.david@vet.bme.hu

## Description of the research infrastructure

During the FIEK project (April 2017 – March 2021), MVM and BME established a unique and specialized laboratory which provides ideal conditions for Power-Hardware-in-the-Loop testing of smart power solutions, up to 400 V AC and 750V DC in 30kVA power range. It consists of a Real-time power system simulator, a four-quadrant linear amplifier, several controllable converters, a grid emulator, electronic load, battery emulator, and several measurement and control units.

## Activities and services

Power Hardware-In-The-Loop testing, microgrid control (PHIL), controller and protection testing. Model-In-The-Loop: Fast simulation of power systems, simulation in Electromagnetic transient (EMT) and phasor modes (RMS). Realization of virtual inertia in a PV system (microgrid) and participation in frequency control. Synchronization and joint island operation of multiple inverters. Voltage control and power sharing between PV and storage subsystems, effects of solar or storage inverters on system dynamics. Fail-safe design of communication-based control systems.

**Core equipment are:**

- OP5700 real-time computer with 8 physical CPU cores, Virtex 7 FPGA board, 64 digital inputs, 64 digital outputs, 32 analog inputs and 32 analog outputs. IEC61850,

**IEC60870-5-104, Modbus RTU. OP8710 High Voltage Solid State Relay box. SW: eMEGASIM, ePHASORSIM, eFPGASIM.**

- P+4Q Three phase power amplifier with 7kVA per phase, DC-25 kHz.

**Regenerative type controllable inverters with variable filter structure and converter topology, generic inverters for testing new control algorithms:**

- NI-Triphase: AC Active Front-end, bidirectional, 3x 24 A.
- Imperix BoomBox, 8x PowerTrench PEB8032 power modules (800V), HIL

**Simulator interface for Opal-RT, automated code generation toolbox for Matlab Simulink.**

- Cinergia grid emulator, battery emulator, electronic load in 20-30 kVA range.
- Danfoss FC302 automation drive inverters + dSpace sw tools.
- OMICRON CMS356 linear amplifier.

**Measurement and data logging:**

- LabView National Instruments Crio,
- DEWE2-PA7 network analyzer.
- LECROY - WAVESURFER 104MXS

# Modular Hybrid Drive System Laboratory

**Host institution:**

Budapest University of Technology and Economics (BME), Center for University-Industry Cooperation (FIEK)

**RI location:**

Budapest, BME campus

**Status:**

Fully operational, 2020-

**Partners:**

Siemens Zrt,  
Rolls-Royce Hungary Kft.

**Available services:**

E-vehicle system and component testing; related expertise, Power Hardware in the Loop equipment & on-site complementary techniques

**Website:**

<https://fiek.bme.hu/english>

**Person in charge:**

László Lengyel, Director of BME FIEK  
[lengyel@aut.bme.hu](mailto:lengyel@aut.bme.hu)

**Contact:**

[fiek@mail.bme.hu](mailto:fiek@mail.bme.hu)

## *Description of the research infrastructure*

Nowadays the wide spreading of electric vehicles generated the need for special power electronics equipment for testing electric vehicles' powertrain. Our mission is to follow the demands of the industry and fulfil the requirements with the highest quality. Productive research and development of the last few years made possible to build the modular hybrid drive system laboratory at the BME campus. With our special self-developed technology we are able to perform tests on any part of the powertrain in the 300kW, 1200V and 15000RPM range. In the future we are going to extend the functionalities not only for electric vehicles but also for any power electronics devices and continuously install high accuracy voltage, current, power and temperature analysing equipment.

The Modular Hybrid Drive System Laboratory was commissioned in 2020 and it is available for E-vehicle developers for drive system and drive component testing.

## *Activities and services*

Our laboratory focuses on two purposes. For companies we provide extensive testing possibilities for complete powertrain systems and powertrain components like motors, generators, power converters, batteries and inverters among many others. With our special high voltage and high power PHIL (Power Hardware In the Loop) system we are able to emulate rotating machines and various speed sensors with flexible user settable electrical and mechanical parameters. We can provide forced air cooling and liquid cooling solutions which fits most of the existing devices. On-site complementary services and our trained power electronics and power control experts are available for support.

We also provide internationally competitive research opportunities for domestic and for foreign users in Central-Europe. The results can be published in peer-reviewed articles, M.Sc. or Ph.D. theses, grant-related research reports, popular science notes, and in the social media. The possible research area includes multilevel high performance converters, power control, PHIL systems, new control strategies and HIL systems. For researchers we have numerous national and international bilateral and industrial projects.

# Isotope Climatology and Environmental Research Centre (ICER)



**Host institution:**  
Institute for Nuclear Research

**RI location:**  
Debrecen

**Status:**  
Fully operational

**International connections:**  
ETH Zürich, IUP Heidelberg,  
University of Arizona

**Available services:**  
isotope analyses of different materials; stable isotope ratio measurements of hydrogen ( $^2\text{H}$ ), carbon ( $^{13}\text{C}$ ), nitrogen ( $^{15}\text{N}$ ), oxygen ( $^{18}\text{O}$ ), sulphur ( $^{34}\text{S}$ ) by IRMS; stable isotope ratio measurements of hydrogen ( $^2\text{H}$ ) and oxygen ( $^{17}\text{O}$ ,  $^{18}\text{O}$ ) by cavity enhanced laser spectroscopy; isotope ratio measurements of copper ( $^{65}\text{Cu}/^{63}\text{Cu}$ ), hafnium ( $^{176}\text{Hf}/^{177}\text{Hf}$ ), neodymium, lead,

strontium ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) and uranium by MC-ICPMS; tritium by the  $^3\text{He}$  ingrowth method;  $^{14}\text{C}$  by AMS; noble gases including  $^3\text{H}/^4\text{He}$  ratio dissolved in water;  $^3\text{H}/^3\text{He}$  age determination; K/Ar and Ar/Ar dating;  $^{230}\text{Th}/^{234}\text{U}$  dating; clumped isotope analysis ( $\Delta 47$ ) of carbonates;

**Website:**  
<https://iker.atomki.hu/en/>

**Person in charge:**  
Zsolt Dombrádi, director  
[director@atomki.hu](mailto:director@atomki.hu)

**Contact:**  
László Palcsu,  
head of ICER  
[palcsu.laszlo@atomki.hu](mailto:palcsu.laszlo@atomki.hu)

## Description of the research infrastructure

The Isotope Climatology and Environmental Research Centre (ICER) as a project and as a laboratory started in 2016. Since then, new state-of-the-art isotope analytical instruments have been installed and used in environmental and earth sciences, together with existing mass spectrometers. The ICER covers a wide dynamic research field from past climate to recent environmental chemistry. Related topics are organized necessarily around a major group of instruments (mainly mass spectrometers) or a certain method. The research direction of ICER involves those multidisciplinary topics in which physical methods can be applied in other fields (geology, hydrology, meteorology, biology, history and environmental protection) to fulfil the aim of the project.

## Activities and services

The inorganic mass spectrometers in the ICER research infrastructure are used in the field of isotope geochemistry, environmental chemistry and geochronology. Two stable isotope ratio mass spectrometer is responsible for the H, C, N, O and S isotope ratio determination (DeltaPLUS XP), as well as clumped isotope ( $\Delta 47$ ) thermometry of carbonates (MAT253 PLUS). A high resolution MC-ICPM (Neptune PLUS) is used to determine various isotope ratios, such as  $^{65}\text{Cu}/^{63}\text{Cu}$ ,  $^{176}\text{Hf}/^{177}\text{Hf}$ ,  $^{142}\text{Nd}/^{144}\text{Nd}$ ,  $^{204,206,207}\text{Pb}/^{208}\text{Pb}$ ,  $^{87}\text{Sr}/^{86}\text{Sr}$ ,  $^{234}\text{U}$ ,  $^{238}\text{U}$ , and  $^{230}\text{Th}/^{234}\text{U}$ . The laser ablation device (NWR213) coupled to a QQQ ICP-MS is used to determine trace elements in solid materials. Three noble gas mass spectrometers are used in isotope hydrology: the Helix SFT is for low-level  $^3\text{H}$  analysis by the  $^3\text{He}$  ingrowth method, as well as for  $^3\text{H}/^3\text{He}$  age determination of young groundwater. A VG5400 and a MM5400 mass spectrometer determine noble gas concentrations in groundwater to determine past recharge temperatures. Radiocarbon ( $^{14}\text{C}$ ) analysis in numerous research areas are performed with a MICADAS accelerator mass spectrometer dedicated for carbon isotopes. Cavity enhanced infrared laser spectrometers are in progress to measure oxygen and hydrogen stable isotope ratios of water samples (Los Gatos Research), as well as carbon isotope ratios of atmospheric  $\text{CH}_4$  and  $\text{CO}_2$  (Picarro). K/Ar and Ar/Ar dating are done by argon isotope mass spectrometers, including an ARGUS VI. A special low-level counter system has been just installed to determine  $^{39}\text{Ar}/\text{Ar}$  and  $^{85}\text{Kr}/\text{Kr}$  ratios for dating groundwater in the range of 0 to 2000 years. The facility is open for mutual research collaborations and analytical services, and aims to broaden and deepen the research fields of interests. The research results of ICER are published in highly ranked peer-reviewed journals, M.Sc. and Ph.D. theses.

# 3DLab- Infrastructure for Fine and Structure Analysis


**Host institution:**

University of Miskolc

**RI location:**

 Miskolc - Egyetemváros C/1  
3515, Hungary

**Status:**

Fully operational, 2020-

**Partners:**

Robert Bosch Kft, ZF Hungária Kft, Infineon Technologies Cegléd Kft, Breuckmann GmbH &amp; Co KG, Thyssenkrupp, ATOMKI, Univ. of Debrecen, Budapest University of Technology and Economics

**International connections:**

J-resources

**RIs:** CERN

**Research organizations:**

ESA, NHM-HAS, Partner in EU H2020 projects, Fraunhofer IFAM, ICAMCyL, LTSM, COMET

**Available services:**

ND residual stress, retained austenite measurements, 3D CT scan with metrology, 3D SEM, ODF, TEM lamella preparation, XRD scan, XRR, SAX, up to 1200°C

**Website:**
<http://3dlabtest.uni-miskolc.hu/>
**Person in charge:**

Prof. Dr. Valéria Mertinger, head of the 3DLab, head of the Institute of Physical Metallurgy Metalforming and Nanotechnology

**Contact:**
[mertinger.valeria@uni-miskolc.hu](mailto:mertinger.valeria@uni-miskolc.hu),  
[3dlab@uni-miskolc.hu](mailto:3dlab@uni-miskolc.hu)  
+36-46-565-111/12-40

## Description of the research infrastructure

The 3DLab is an integrated laboratory for the provision of internationally competitive research, development, and innovation. The laboratory infrastructure and the related professional competences can provide complex answers to questions related to the spatial (3D) structure of materials. The subject of the tests can be metallic, mineral, organic or composite material. The dimensional order of magnitude can be in the range of nanometer to a meter from the area of basic research, raw material research, material and product development, manufacturing, failure or lifetime.

## Activities and services

Stresstech XStress Robot is an advanced X-ray stress analyser. The goniometer attached to the robot arm with ability of fast repositioning to the various areas on the surfaces. Non-destructive residual stress and retained austenite measurements can be carried out on surfaces with great accuracy and without size and geometry limit. Depth profile measurements and non-destructive pole figure determination using our own patented method is also available.

YXLON FF35 Computer Tomograph is an instrument for characterizing the whole 3D structure of a materials. Due to the dual X-ray tube setup the bigger sample size at average resolution, and the smaller sample size at high resolution can be investigated. The observable materials have a broad range of size and material composition. It's not only for detection of cracks or voids in the material, but with the metrology function, the whole geometry is reconstructable and quantifiable in 3D, with high resolution.

Thermo Scientific Helios G4 PFIB CXe Scanning Electron Microscope with Correlative Laser Cutting is capable of up to 0.6 nm resolution. The correlative laser cutting and inductively coupled Xe-plasma can process big volumes and surfaces of materials. The precisely focused plasma beam can cut 3 nm thin slices, so high resolution 3D chemical element maps and EBSD maps can also be constructed. TEM grids can be studied in STEM scanning transmission mode for dark field, bright field and chemical composition analyses. The Bruker D8 Discovery multipurpose Xray diffractometer with unique X-ray optical and geometry solutions, such as the Da-Vinci control, a push-plug automatic parts recognition, parallel beam and Bragg-Brentano geometry, capillary sample holder and motorized stage allows the investigation of samples with various sizes and amounts. The energy dispersive position sensitive detector opens a new dimension in data acquisition and measurement dynamics. The other unique attachment is a heating stage with 1200 °C, thus fast thermal transformations are observable in inert gas or vacuum. The instrument has small angle X-ray scattering (SAXS) and X-ray reflectometry (XRR) capabilities. For the low- and small angle measurements a software controlled motorized air scatter screen is also available.

# International territorial water management and climate adaptation instruments centre



**Host institution:**  
University of Debrecen, Institute of Water and Environmental Management

**RI location:**  
4032 Debrecen,  
Böszörményi u.138., Hungary

**Status:**  
Partially operational, 2020-

**International connections:**  
**RIs:** Ain Shams University,  
Mansoura University,

Slovak University of Agriculture in Nitra,  
University of Oradea  
Global Water Partnership  
Central Eastern Europe

**Research organizations:**  
CABI, DHI, Partners in EU projects  
(H2020 currently: WATERAGRI)

**Available services:**  
Researches in the fields of agriculture, water management and environmental sciences.

**Website:**  
<https://mek.unideb.hu/node/233>

**Person in charge:**  
János Tamás, Head of Institute

**Contact:**  
tamas@agr.unideb.hu

## Description of the research infrastructure

The International River Basin Management and Climate Adaptation Centre is launched in 2019 at the Water and Environmental Management Institute, University of Debrecen. The Centre is a state of the art research facility in Hungary and Central Europe in the agricultural water management discipline. The climate adaptation solutions to be developed here is brought significant breakthrough in addressing drought, inland waters and urban hydrology. The complex infrastructure is a unique system with two interconnected parts: hydrological measurement facilities and the controlled greenhouse research. The "agricultural" campus of the University of Debrecen is an ideal place for training, research and professional consulting. Instruments installed here include:

watershed monitoring devices; field drainage planning equipment; 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 equipment; irrigation water quality protection devices and equipment for data-processing. The IT network supports the computerized data processing, water management planning and decision-making, the data collection system of the entire unit, and the data acquisition 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 equipment is met by a sustainable solar energy power system.

## Activities and services

Activities and services became available in the framework of the project such as experimental and demonstration tools for hydrological and hydraulic researches; soil, water, weather and plant water balance; groundwater monitoring system; high resolution precipitation monitoring; researches on precision irrigation technology. The unique infrastructure further enhances the multidisciplinary educational and research activities of the University of Debrecen in the transboundary river basin of the Tisza River. The infrastructure serves the implementation of a Horizon 2020 project: the WATERAGRI. The WATERAGRI project is about researching the new frontiers in integrated water resources management of small agricultural catchments to improve both European agricultural production and the status of local ecosystems. The WATERAGRI consortium consists of a group of 23 partners from 12 European countries. The infrastructure implemented in the project is connected to the institution's researcher bases with the domestic and international research network in the fields of agriculture, water management and environmental sciences.

and surfaces of materials. The precisely focused plasma beam can cut 3 nm thin slices, so high resolution 3D chemical element maps and EBSD maps can also be constructed. TEM grids can be studied in STEM scanning transmission mode for dark field, bright field and chemical composition analyses.

The Bruker D8 Discovery multipurpose Xray diffractometer with unique X-ray optical and geometry solutions, such as the Da-Vinci control, a push-plug automatic parts recognition, parallel beam and Bragg-Brentano geometry, capillary sample holder and motorized stage allows the investigation of samples with various sizes and amounts. The energy dispersive position sensitive detector opens a new dimension in data acquisition and measurement dynamics. The other unique attachment is a heating stage with 1200 °C, thus fast thermal transformations are observable in inert gas or vacuum. The instrument has small angle X-ray scattering (SAXS) and X-ray reflectometry (XRR) capabilities. For the low- and small angle measurements a software controlled motorized air scatter screen is also available.





# Bioanalytical instrumentation for analyte examination at molecular and cellular levels



UNIVERSITY of  
DEBRECEN

**Host institution:**

Faculty of Medicine, University of Debrecen

**RI location:**

Debrecen, Nagyerdei campus

**Status:**

Fully operational

**Partners:**

University of Szeged, University of Pécs, Semmelweis University

**International connections:**

**RIs:**

University of Siena, Italy,  
University of North Texas,  
USA

**Research organizations:**

European BioImaging node,  
ELIXIR Proteomics

**Available services:**

protein identification, post-translational modification detection, label-based and label-free mass spectrometry-based quantification, intact protein examination, metabolite identification, amino acid analysis, detection of biomolecular interactions, high speed confocal microscopy scanning, HTS screening

**Website:**

<http://3dlabtest.uni-miskolc.hu/>

**Person in charge:**

Prof. József Tózsér, vice-rector of the University of Debrecen, tozser@med.unideb.hu

**Contact:**

Dr. Éva Csősz,  
cseva@med.unideb.hu

## Description of the research infrastructure

The research infrastructure acquired with the help of the GINOP-2.3.4-15-2016-00002 is hosted by various departments of the Faculty of Medicine and is embedded into the Core Facility framework of the University of Debrecen. The instrument systems fit into the instrumentation of the different, already existing core facilities, ensuring in this way the high standards of scientific excellence. The long years of expertise of the core facility staff, the highly collaborative working environment and the stable operational framework provided by the University of Debrecen make these core facilities good partners in any R&D type projects.

## Activities and services

The high precision and high speed Orbitrap Tribrid mass spectrometry system equipped with ESI and nano ESI ion sources, ETD, HCD and CID collision techniques, provides a large spectrum of analytical possibilities for the examination of proteins and small molecules present in biological samples even at femtomolar levels. The mass spectrometer along with the Transcend™II TurboFlow™ system is part of the Proteomics Core Facility hosted by Department of Biochemistry and Molecular Biology and allows for the rapid online sample preparation and analysis. The instrumentation along with performant software make possible the identification and quantification of various compounds present in complex matrixes. The Monolith NT instruments series, including NT.115 LabelFree and NT.115 Red/Blue devices, are based on the phenomenon of microscale thermophoresis (MST) and they provide broad applications for detection of interactions in the range of pM to mM binding affinities between many types of biomolecules. The MST based instruments are excellent additions to other equipment (Biacore3000, ITC200) used in the Biomolecular Interaction Core Facility hosted by the Department of Medical Chemistry to determine molecular interactions based on surface plasmon resonance (SPR) and isothermal titration calorimetry (ITC). The ZEISS LSM 880 AiryScan being part of the Functional Imaging Laboratory, Department of Physiology, allows the users to investigate large fields of view with high speed scanning confocal microscope at an unsurpassed image quality. It is designed for optimized productivity to investigate subcellular structures at a new level of detail. The system provides the speed to monitor molecules and their interactions in space and time while minimizing the input of light. The EnVision 2105 Multiplate reader situated in the Department of Immunology is a HTS-screening system providing exceptional speed and maximum sensitivity across a wide spectrum of detection technologies. These include fluorescence, ultra-sensitive luminescence, absorbance, time-resolved fluorescence and TR-FRET methods, as well as AlphaScreen®, and AlphaLISA® technologies, which offer unparalleled sensitivity and precision in the detection of both intracellular processes and secreted factors.





# Bioluminescence Hungary



**Host institution:**

University of Debrecen, coordinator

**RI location:**

University of Debrecen  
Semmelweis University, Budapest  
Biological Research Centre, Szeged  
Femtonics Ltd., Budapest

**Status:**

Operational since 2010

**Partners:**

University of Pécs,  
Nuclear Research Centre Debrecen,  
Scanomed Ltd.,  
MEDICOPUS Health Service  
Nonprofit Ltd. Kaposvár,  
Institute of Experimental  
Medicine Budapest

**International connections:**

Euro-Bioluminescence (EuBI) ERIC

**RIs:**

Cellular Imaging Hungary, EuBI Node

**Available services:**

Advanced light and electron  
microscopy Preclinical and medical  
imaging

**Website:**

<https://www.eurobioimaging.eu>

**Person in charge:**

János Szöllősi, EuBI board member  
szollo@med.unideb.hu

**Contact:**

György Vámosi, EuBI board member  
vamosig@med.unideb.hu

## Description of the research infrastructure

Modern light microscopy and medical imaging play an increasing role in basic and applied biomedical research and diagnostics. Euro-Bioluminescence (EuBI) ([www.eurobioimaging.eu](http://www.eurobioimaging.eu)) was set up in 2010 under the auspices of European light microscopy and medical imaging microscopy laboratories to operate as an ESFRI ERIC, which was legally formed in 2019, with Hungary among its 14 founding members. The aim of EuBI is to serve life scientists with state-of-the-art imaging techniques ranging from microscopy to medical imaging throughout Europe. In 2009, the Hungarian Bioluminescence Network was established. Several member labs at the Univ. of Debrecen, Biological Research Centre, Szeged, Semmelweis University and Femtonics Ltd., Budapest formed the "Cellular Imaging Hungary" EuBI Node after a successful Node application. In 2020, the University of Pécs is submitting an application to join the Node as well. A second application is submitted to form the "Medical and Preclinical Imaging Hungary" Node with the participation of the University of Debrecen, Nuclear Research Centre Debrecen, Scanomed Ltd., Semmelweis University Budapest, University of Pécs and MEDICOPUS Health Service Nonprofit Ltd. Kaposvár.

## Activities and services

The Cellular Imaging Hungary EuBI Node and its partner labs have been upgraded in recent years with the help of EU and governmental grants to reach state-of-the-art in several imaging technologies. Cutting-edge techniques are also developed and manufactured at these labs. A non-exhaustive list of techniques serving academic and industrial users at the infrastructures includes: super-resolution microscopies (stimulated emission depletion, photoactivated localization, stochastic optical reconstruction, structured illumination), 2D and 3D fast multi-photon laser scanning microscopy; Förster resonance energy transfer; fluorescence lifetime imaging; fluorescence (cross)correlation spectroscopy; differential polarization laser scanning microscopy; Rescan confocal microscopy; optical tweezers; atomic force microscopy; stimulated Raman spectroscopy; high throughput microscopy and automated image analysis, single cell laser dissection; correlative light and electron microscopy; serial block-face scanning electron microscopy; functional medical imaging equipment (CT, PET/CT, MRI, SPECT, fMRI, NEXSTIM); imaging equipment for preclinical, translational research (e.g. mini-PET, nano-PET/CT, PET/MRI, fMRI, micro-CT, bioluminescent imager).

wide spectrum of detection technologies. These include fluorescence, ultra-sensitive luminescence, absorbance, time-resolved fluorescence and TR-FRET methods, as well as AlphaScreen®, and AlphaLISA® technologies, which offer unparalleled sensitivity and precision in the detection of both intracellular processes and secreted factors.





# Biosafety Level-4 Laboratory at University of Pécs (BSL-4)



UNIVERSITY OF PÉCS  
SZENTÁGOTHAÍ RESEARCH CENTRE

**Host institution:**

University of Pécs, Szentágotthai Research Centre (UP-SRC)

**RI location:**

Pécs, University Campus

**Status:**

Fully operational, 2017-

**Partners:**

Mostly universities and other academic research institutes

**International connections:**

**RIs:**

University of Kent, NIAID, USAMRIID, University of Boston, Vietnam Academy of Sciences and Technology, PHE

**Research organizations:**

ERINHA, Partners in EU projects (H2020), COST Action

**Available services:**

Traditional virological, microbiological (tissue culture, virus isolation), molecular biological (recombinant DNA techniques, protein expression) and immunological (ELISA, WB, IF staining) techniques are available.

**Website:**

<https://szkk.pte.hu/>

**Person in charge:**

Prof. Dr. Jakab Ferenc, Scientific Director of UP-SRC, [jakab.ferenc@pte.hu](mailto:jakab.ferenc@pte.hu)

**Contact:**

Prof. Dr. Jakab Ferenc, Leader of BSL-4 Laboratory, [jakab.ferenc@pte.hu](mailto:jakab.ferenc@pte.hu)

## Description of the research infrastructure

The Szentágotthai Research Centre of the University of Pécs is a new research institute established on the basis of modern international science organizational and management normatives. It covers all aspects of education, research and innovation in the fields of biomedical, natural and environmental sciences. The infrastructure and all the well-equipped laboratories provide an excellent basis to become a well-known, leading research facility in Hungary, as well as in Central Europe with an extensive, fruitful national and international collaboration network.

The BSL-4 virological laboratory is well-equipped, designed properly and meets the requirements of the laboratory protocol declared by the CDC-BMML (5th edition), ensuring the safe working conditions with highly infectious materials. The BSL-4 laboratory has official certificates for Occupational Health and Safety Management System (OHSAS 18001:2007) also. Besides the BSL-4 facility, the research group has an already suitably running molecular virological laboratory which provides all the necessary instruments. In 2020, the laboratory was officially assigned as the National Laboratory of Virology, which is primarily responsible for virological research activities in Hungary.

## Activities and services

The main profile of the group is the research of viral zoonoses (diseases that are spread from animals to humans caused by viruses). Due to global warming and the expansion of human living-space, animal viruses pose a growing threat for human - and veterinary health. Pathogens causing severe epidemics are emerging more frequently due to global activities. One of the aims of our research is to identify well known and new pathogens in samples originating from Hungary and from abroad through our extensive international collaboration network. Studies intend to monitor their prevalence, characterize their genetic background and describe the mechanism of viral infection. Viruses carried by rodents, bats, mosquitoes and ticks are studied primarily. We have established well-functioning collaborations with stakeholders in public health, animal health and industry, and we also contribute to the development of diverse diagnostic methods for the pathogens characterized in the laboratory. In addition to basic research, we are conducting important research in the development of antiviral drugs, as well as there is possibility of vaccine development projects, both primarily for highly infectious viruses.







# European Life-sciences Infrastructure for Biological Information



**Host institution:**

Research Centre for Natural Sciences, Institute of Enzymology

**RI location:**

Budapest 1117, Magyar Tudósok körútja 2.

**Status:**

Fully operational, 2019-

**Partners:**

University of Debrecen, University of Pécs, Semmelweis University, Eötvös Loránd University, Centre for Ecological Research, Institute for Veterinary Research, National Institute of Oncology, University of Veterinary Medicine Budapest, Biology Research Centre Szeged, Rényi Institute, National Agriculture Research and Innovation Centre

**International connections:**

ELIXIR partner institutes including Swiss Institute of Bioinformatics,

**RIs:**

ELIXIR

**Available services:**

CCTOP, HMMTOP, TMDet, TmFoldWeb, IUPred, KM-plotter, ANCHOR, IsoMut, Kooplex, MÉTA, G-2-O, Recurrence Online, ROC plotter, HTP, TOPDOM, TOPDB, TSTMP, PDBTM, National Cancer Registry

**Website:**

<http://www.elixir-hungary.org/>

**Person in charge:**

Dr. Balázs Gyórfy, Head of Node, gyorffy.balazs@ttk.hu

**Contact:**

Réka Vajda, vajda.reka@ttk.hu

## Description of the research infrastructure

Bioinformatics comprises the computationally supported analysis of life science data employing algorithms, programs, and databases. Worldwide, Hungary is among the 40 most advanced countries in this new field. ELIXIR is a research infrastructure which organizes the bioinformatic resources available at the partner institutes into a single network.

## Activities and services

We work in three major directions:

- By establishing communities we focus on pre-set scientific topics. Such projects include rare diseases, 3D bioinformatics, human copy number variation, intrinsically disordered proteins and many more.
- We put great emphasis on the teaching of bioinformatics. Since this is a relatively new field of science, knowledge is almost non-existing. We organize courses across the country and also enable members to invite international teachers to boost teaching capacity. Primary focus is on PhD fellows, but gradual students are also targeted.
- We establish and maintain services necessary to execute bioinformatic data analysis. These include online services many of which are world-leading (including CCTOP, HMMTOP, ANCHOR, KM-plotter, ROC-plotter) as well as data processing platforms (GALAXY) and data repositories (Hungarian EGA server).

Leading scientific topics include oncology (seven active ELIXIR research groups), COVID-19 research (three active ELIXIR research groups) and protein structure (four active research groups).

A major future goal of the Hungarian Node is to establish a framework for the country-wide bioinformatic data processing of medical omics data.





# Hungarian European Clinical Research Infrastructura Network (HECRIN)



**Host institution:**

University of Pécs (UP), Szentágotthai Research Centre

**RI location:**

Pécs

**Status:**

Distributed infrastructure, 2014-

**Partners:**

University of Szeged, Semmelweis University, University of Debrecen, National Institute of Oncology, State Hospital for Cardiology, National Institute of Rheumatology and Physiotherapy, National Institute of Clinical Neurosciences, Gottsegen György Hungarian Institute of Cardiology, Korányi National Institute of Pulmonology, Heim Pál Children's Hospital, MCRN Hungary (Medicine for Children Research Network), Hungarian Academy of Sciences - Research Centre for Natural Sciences Brain Imaging Centre,

HunPedNet (Hungarian Pediatric Network), AdWare Research Ltd., Pharmahungary 2000 Ltd., National Institute of Pharmacy and Nutrition

**International connections:**

ECRIN-ERIC

**Research organizations:**

clinical trial units (CTUs) of HECRIN member institutions

**Available services:**

management of clinical trials, education

**Website:**

<https://hecrin.pte.hu>, <https://szkk.pte.hu>

**Person in charge:**

Prof. Dr. Gábor L. Kovács, [kovacs.l.gabor@pte.hu](mailto:kovacs.l.gabor@pte.hu)

**Contact:**

Dr. Zita Tarjányi, European Correspondent, [tarjanyi.zita@pte.hu](mailto:tarjanyi.zita@pte.hu)

## Description of the research infrastructure

The European Clinical Research Infrastructure Network (ECRIN-ERIC) is a landmark non-profit organization included in the ESFRI Roadmap to support non-commercial, science-based, multicentric pharmaceutical research in Europe. In 2014, the Hungarian member organization - the HECRIN Consortium - became a full member of ECRIN-ERIC. HECRIN Consortium is the scientific partner, the national hub of ECRIN-ERIC in Hungary with the goal to provide support to national investigators seeking to internationalize clinical trials, and to involve their country in clinical trials initiated by investigators in other European countries. The results of human clinical trials have a significant impact on the development of clinical medicine.

## Activities and services

As a full member of ECRIN, the HECRIN consortium strives to harmonize European clinical research through a wide range of services (database management, partner search, reference validation, education). Through this partnership, and various international and national grants, HECRIN coordinates high-quality, independent and fully transparent multinational academic (investigator-initiated) clinical trials, enhancing the capabilities of the national clinical research infrastructure.

The European network is based on the connection of national networks of Clinical Trials Units (CTU). CTUs are specialised biomedical research units which design, centrally coordinate and manage clinical trials, prognostic, diagnostic studies, and meta-analyses, deal with the design of the study, its organisation, logistics, centre selection, data management, monitoring, data analysis, pharmacovigilance and reporting. HECRIN developed a high quality, integrated clinical trial network at all four university-based clinical research facilities in Hungary and one for pediatric research, which allows to enhance Hungary's capacity for conducting innovative, high quality clinical research involving pharmaceuticals, nutraceuticals or clinical care pathways, as well as clinical investigation of medical devices.

In addition, the Consortium promotes the continuous professional training of the study team and the supporters, as well as it strives with special efforts for the utilization of clinical data assets for research purposes.

During the COVID-19 pandemic HECRIN Consortium has become the main partner of the Hungarian Ministry of Innovation and Technology in the field of government-sponsored anti-Covid trials.





# Integrated Infrastructure for Molecular Science and Molecular Medicine (I2M2)



UNIVERSITY of DEBRECEN

**Host institution:**

Institute of Chemistry,  
University of Debrecen

**RI location:**

Debrecen, University of Debrecen,  
Chemistry Campus

**Status:**

Fully operational, 2018-

**International connections:**

Karlsruhe Institute of Technology;  
Institut Pasteur de Lille; Institut  
Pasteur de Montevideo; Bizkaia  
Science and Technology Park,  
Derio; Griffith University; Technische  
Universität Darmstadt; University of  
Manchester; Division of Molecular  
Biology, Innsbruck Medical University

**International connections:**

**Research organizations:** Partners  
in EU projects (EAST NMR,  
INSTRUCT, Bio- NMR,  
COST, iNEXT)

**Available services:**

NMR, CE-MS and X-ray diffraction  
measurements

**Website:**

<http://i2m2.unideb.hu/index.php>  
[http://i2m2.unideb.hu/index\\_en.php](http://i2m2.unideb.hu/index_en.php)  
<https://debnmr.unideb.hu/en>

**Person in charge:**

Attila Gáspár, Head of CE-MS facility,  
[gaspar@science.unideb.hu](mailto:gaspar@science.unideb.hu)  
Attila Bényei, Head of X-ray facility,  
[abenyei@unideb.hu](mailto:abenyei@unideb.hu)

**Contact:**

Katalin E. Kövér,  
Head of NMR facility,  
[kover@science.unideb.hu](mailto:kover@science.unideb.hu)

### *Description of the research infrastructure*

The Integrated Infrastructure Center established in 2018 at the University of Debrecen within the frame of I2M2 project (GINOP-2.3.3-15-2016-00004 financed by European Regional Development Fund) serves as a core facility in support of advanced multidisciplinary research in the field of molecular and life sciences, including structural chemistry, structural biology, pharmaceutical, food and environmental research. The state-of-the-art instruments installed in the Infrastructure Center extend the scope of academic and innovation research activities in progress currently or in the future and provide indispensable links between academic and industrial research at national and international level, enhancing visibility of the University of Debrecen in the European Research Area.

### *Activities and services*

The Bruker Avance NEO 700 MHz NMR spectrometer equipped with Prodigy TCI cryoprobe offers outstanding sensitivity and resolution, supporting research activities in diverse areas. The NMR facility (DEBNMR) also operating three other spectrometers (Bruker 360, 400, 500) offers a wide range of high resolution, multinuclear and multidimensional NMR measurements for structure determination and dynamics study of carbohydrates, peptides, proteins and other synthetic and natural products. The research team has special expertise in method development for sensitive and reliable measurement of important NMR parameters.

The mass spectrometer (maXis II (Bruker)) equipped with quadrupole technology in conjunction with a time-of-flight analyser (ESI-QTOF-MS) is one of the highest resolution and most sensitive mass spectrometers being available in the market, allowing determination of accurate molecular masses and structures of small to large (bio) molecules. The hyphenation with capillary electrophoresis (7100 Agilent)(CE) provides a high performance analytical instrumentation for the analysis of biological samples.

The Bruker D8 Venture X-ray diffractometer equipped with high brilliance dual microsource (Cu and Mo), high sensitivity detector and low temperature unit allows to measure crystal samples between 90 and 500K. Crystal and molecular structures of small molecules, metal complexes or even proteins can be determined. With the present configuration of the equipment powder diffraction measurements are also feasible.





# Biobank Network

**Host institution:**

Semmelweis University, Budapest

**RI location:**

Semmelweis University Campus

**Status:**

Fully operational

**Partners:**

Gedeon Richter Plc., Center for Molecular Fingerprinting, Oncompass Medicine Ltd.

**International connections:****Research organizations:**

European Reference Network

**RIs:**

BBMRI

**Website:**

[www.semmelweis.hu](http://www.semmelweis.hu)

**Person in charge:**

Prof. Dr. Mária Judit Molnár, Director of Institute, Genomic Medicine and Rare Disorders

**Contact:**

András Fodor, Project Manager, Genomic Medicine and Rare Disorders  
[fodor.andras@med.semmelweis-univ.hu](mailto:fodor.andras@med.semmelweis-univ.hu)

### *Description of the research infrastructure*

Semmelweis University has been one of the leading biomedical institutions of higher education in Hungary and Central Europe for the last 250 years. The University today is handling 2.5 million patient visits each year within nearly 40 departments. Research, development, and innovation (R&D&I) take place in the areas of living natural sciences, and social sciences. Within these, life science R&D&I activities are the most prominent. The R&D&I results quickly make their way into clinical and health sciences as well as into the University's educational activities and the curriculum. The synergies also manifest themselves in the various specialized networks operating at the University (e.g. nanotechnology, bio-imaging, genomics, biobank), as well as in the research university modules (diagnostics, technology, therapy, prevention) and the dynamic collaborations which have been developing within these areas. The Semmelweis Biobank Network was established in 2010 with the goal of efficiently using the synergies that occur in patient care, education, research/development and a wide spectrum of health care areas all under University premises.

### *Activities and services*

The Biobank Network at Semmelweis University consists of 14 institutes and 15 biobanks. The aggregate sample size for these institutes currently stands at 87 000, registering over 10 000 new samples in 2019. Sample types vary from DNA, skin, nerve to muscle and other biopsy tissues. Areas covered by the Biobank Network include: cardiology, neurology, psychiatry, hematology, nephrology, rheumatology, ophthalmology, endocrinology, dermatology. The University has a Rare Disease network with large biobank.

Samples from the Semmelweis Biobank Network have been used in over 60 research projects during the networks existence. A main strategic goal for Semmelweis University is to enhance the role of the Biobank Network both internally and externally. A key element in achieving this goal is our application to the Biobanking and BioMolecular Resources Research Infrastructure (BBMRI). The University is also in pursuit of offering commercialized services based on the Biobank Network, tightening the relationship with other players from the biobanking field such as industry, biobankers and other private sector parties. The currently running initiatives are all in the hope of making significant contributions to biomedical research and to the evolution of new treatment methods.





# Autonomous Vehicles Research Centre (AVRC)

**Host institution:**

Institute for Computer Science and Control (SZTAKI), Eötvös Loránd Research Network

**RI location:**

Budapest

**Status:**

Status: Fully operational, 2015-

**Partners:**

BME, SZE, ZalaZONE

**Research organizations:**

TUM, Uni. of Minnesota, SUPAERO, TU Delft, TU Eindhoven

**Available services:**

Autonomous test vehicles (road and airborne), custom sensor and actuator development, sensor fusion, virtual simulation environment, model based system development and testing

**Website:**

<https://www.sztaki.hu/>

**Person in charge:**

Péter Gáspár  
gaspar@sztaki.hu

**Contact:**

Bálint Vanek  
vanek@sztaki.hu  
Alexandros Soumelidis  
soumelidis@sztaki.hu

## Description of the research infrastructure

Systems and Control Laboratory at the Institute for Computer Science and Control (SZTAKI) has a long tradition in the research of model based analysis and control technologies in several fields, including safety-critical, fault-tolerant and reconfigurable systems, multi-objective and integrated control. Experimental platforms are available as key research infrastructure and are developed continuously with the aims of providing flexible,

versatile test environments for supporting research activities of vehicle control. One of the test platforms is an electric passenger car equipped with computer-controlled functions. Multiple on-board embedded systems as well as multiple sensors serve as the base or performing experiments in a wide range of automated control problems. The experimental system is coupled with a model-based system design and simulation environment consisting of commercial development tools as well as custom developed reusable prototype components, serving the needs of the theoretical and experimental work. An excellent opportunity to realize tests and experiments by this platform is provided by ZalaZone automotive test field. Under the framework of the Technological Centre established in the test field SZTAKI and Széchenyi University maintains a laboratory that allows for efficient on-site work. Most of the key sensing and control equipment are also used onboard the Sindy unmanned aerial vehicle research platform. Key technologies, like inertial and navigation satellite based sensor fusion, or vision based navigation are tested on both ground and airborne platforms. Coupled with the vehicles the institute also hosts an extensive hardware-in-the-loop test environment, where novel safety critical software components can be tested on the actual hardware before implementing them onboard the vehicles.

## Activities and services

The experimental vehicle control platforms provide cooperation possibilities in the validation and testing of new methods and algorithms. Experimental verification of concepts improves acceptability of the results by the scientific and technological community. Beyond the benefits to partners the experimental platform offers opportunity for cooperation with other research institutes, and universities, as well as with industrial partners in the field of autonomous systems. SZTAKI is open to participate in joint research and development activities, national and international competitions and tenders. The unique experimental platforms can also be involved in the university education, and provides the opportunity to realize university student programs.

Clinical Trials Units (CTU). CTUs are specialised biomedical research units which design, centrally coordinate and manage clinical trials, prognostic, diagnostic studies, and meta-analyses, deal with the design of the study, its organisation, logistics, centre selection, data management, monitoring, data analysis, pharmacovigilance and reporting. HECRIN developed a high quality, integrated clinical trial network at all four university-based clinical research facilities in Hungary and one for pediatric research, which allows to enhance Hungary's capacity for conducting innovative, high quality clinical research involving pharmaceuticals, nutraceuticals or clinical care pathways, as well as clinical investigation of medical devices.

In addition, the Consortium promotes the continuous professional training of the study team and the supporters, as well as it strives with special efforts for the utilization of clinical data assets for research purposes.





# Cyber Physical Pilot Production System

**Host institution:**

Institute for Computer Science and Control (SZTAKI)

**RI location:**

Budapest SZTAKI campus, Győr,  
Széchenyi University Campus

**Status:**

Status: Fully operational, 2018-

**Partners:**

Budapest University of Technology  
and Economics, Széchenyi University  
in Győr,

**International connections /****Research organizations:**

Fraunhofer Austria

**Available services:**

experiments with new technologies,  
training, knowledge transfer,  
individual mechatronics projects

**Website:**

<https://ipar40kutatas.hu/>

**Person in charge:**

Dr Váncza József  
Head of the laboratory  
vancza@sztaki.hu

### *Description of the research infrastructure*

The Research Laboratory on Engineering and Management Intelligence (EMI) at the Institute for Computer Science and Control (SZTAKI) has built up two learning factory facilities in Budapest and Győr, providing an infrastructural background for experiments and hands-on experience in various aspects of cyber-physical production systems (CPPS). The facility in Budapest, named "Smart Factory", is a compact, high-level but functional representation of an entire production site, occupying an area of ca. 30 m<sup>2</sup>. While no actual production process is taking place, re-usable workpieces still undergo physical handling representative of processes in a production plant. The learning factory site established at the premises of Széchenyi University in Győr focuses on collaborative processes on the shop-floor level, with several workstations set in a common open space of ca. 75 m<sup>2</sup>. The workstations comprise a central element with one or more collaborative robots, and a set of configurable table extensions where assembly and auxiliary operations can take place. The structure of the workstations is designed for collaborative involvement of humans and robotic resources in assembly processes, with many of the physical resources being equally accessible to human and robotic handling. The workstations have an open spatial arrangement, blending into the shop-floor area without fixed boundaries, representing one of the possible future factory layout concepts. Most operations are conceived to leave the choice open for using robots or human workforce, and, similarly, material streams between workstations can equally be served by humans or automated guided vehicles (AGVs).

### *Activities and services*

Both learning factory facilities retain substantial flexibility and evolvability in their composition, enabling both the processes themselves and the underlying automation infrastructure to be subject to education, training, research and development. The learning factories have already been host to training and education activities, and the development of a harmonized didactic portfolio is ongoing. In this regard, two tracks are followed. An industrial track is built around services for industrial enterprises, integrating customized demonstrations and risk-free experiments with new technologies, as well as training and knowledge transfer programs for employees of the enterprises. The developed framework supports the modeling, planning and execution control of processes in cyber-physical production systems, enabling process transparency, virtual representation and accessibility of physical components for observation and control in a structured approach. In parallel, an academic track comprises participation in higher education via individual student projects (e.g., leading up to BSc, MSc or PhD theses), and a project-oriented course for elaborating mechatronics solutions for the utilization of clinical data assets for research purposes.





# Extreme Light Infrastructure Attosecond Light Pulse Source (ELI-ALPS)

**Host institution:**

ELI-HU Non-Profit Ltd (project company)

**RI location:**

Szeged, Hungary

**Status:**

Partial operation, full operation expected from 2023

**Partners:**

In the ELI project ELI-ALPS is partnered with ELI BL (Prague) and ELI NP (Bucharest). In national projects the Wigner Research Centre, the University of Szeged, ATOMKI, the Szeged based Biological Research Centre and the University of Pécs are collaborating partners. Implementation is ensured through international partnerships.

**International connections:**

ELI-HU is a member of the HEP Tech Network, and a founding member of the future ELI ERIC.

**RIs and research organizations:**

ELI-HU has signed over 15 Memoranda of Understanding with universities and research institutes worldwide.

**Available services:**

the research technology at ELI-ALPS is under implementation: it consists of ultrashort high-power, high-repetition-rate laser sources in the NIR-MIR regime, as well as secondary light (THz and XUV) and particle sources in various pump-probe arrangements, and experimental stations.

**Website:**

[www.eli-alps.hu](http://www.eli-alps.hu)

**Person in charge:**

Gábor Szabó  
Managing Director of ELI-HU,  
[Gabor.Szabo@eli-alps.hu](mailto:Gabor.Szabo@eli-alps.hu)

**Contact:**

Katalin Varjú  
Science Director of ELI-HU,  
[Katalin.Varju@eli-alps.hu](mailto:Katalin.Varju@eli-alps.hu)

### Description of the research infrastructure

ELI is the first laser based user facility in the world where light-matter interactions can be studied at the highest intensities to date, in the so-called ultrarelativistic range at the fastest time scales from femto- to attoseconds. It is also the first civilian large-scale, high-power laser research facility to be realized with trans-European cooperation and the involvement of a global scientific community within the ELI project. With coordinated management and research strategies, Hungary, the Czech Republic and Romania are simultaneously working towards the full-scale implementation of the project through the construction of three laser facilities, representing the three pillars of the distributed research infrastructure with respective missions in attosecond, particle acceleration and photonuclear applications.

The main objective of ELI-ALPS, the Hungarian pillar of the Extreme Light Infrastructure, is the establishment of a unique research facility which provides ultrashort (few-cycle), high-repetition-rate light pulses in the frequency range between THz (10<sup>12</sup> Hz) and X-ray (10<sup>18</sup>-10<sup>19</sup> Hz) for developers and end-users.

### Activities and services

ELI-ALPS is dedicated to support fundamental and applied research in physical, biological, chemical, medical and materials sciences at extreme short time scales. The state-of-the-art laser systems and the subsequent outstanding secondary sources generate the highest possible peak powers at the highest possible repetition rate in a wide spectral domain in the form of few- to single-cycle pulses. The facility – with highly trained scientific staff – aims to provide access to its research infrastructure for user groups from all around the world. As the first systems are already online, ELI-ALPS has opened a commissioning user programme, where the range of available equipment is continuously growing.

**The main research fields and applications at ELI-ALPS include:**

- High-peak- and high-average-power laser development in the few-cycle regime
- Development, characterization and application of high-repetition-rate and high-power attosecond sources
- Studying ultrafast (femtosecond and attosecond scale) dynamics
- Particle acceleration by ultraintense laser fields, and applications
- Biomedical effects of pulsed irradiation
- Biomedical imaging technologies
- Energy research: from solar cells to artificial photosynthesis
- High-peak-power photonics





# Functional Materials Laboratory (FunMatLab)

**Host institution:**

Wigner Research Centre for Physics

**RI location:**

Budapest, KFKI campus

**Status:**

Fully operational, 2012-

**Partners:**

Centre for Energy Research

**International connections:**

**RIs:** ESRF, EU-XFEL, SwissFEL, ELI-Beamlines

**Research organizations:** ERC, NRDIO, Hungarian Academy of Sciences

**Available services:**

Sample preparation by MBE and chemical methods, sample modification by ion implantation, ion-beam analysis, Mössbauer spectroscopy, X-ray absorption (XANES, EXAFS) and X-ray emission (XES) spectroscopies, fs-time-resolved transient optical absorption

spectroscopy, time-resolved fluorescence spectroscopy and stimulated Raman scattering spectroscopy. Neutron reflectometry (available in the frame of collaboration with the Centre for Energy Research).

**Website:**

<https://wigner.hu/nao/en/facilities>

**Person in charge:**

Peter Levai, Director General of Wigner RCP, [levai.peter@wigner.hu](mailto:levai.peter@wigner.hu)

**Contact:**

Edit Szilágyi, Head of the Department, [szilagyi.edit@wigner.hu](mailto:szilagyi.edit@wigner.hu)

### *Description of the research infrastructure*

Predecessors of the Functional Materials Laboratory (FunMatLab) date back to the 1960-ies when materials analysis and engineering with -photons and X-rays, neutrons and accelerated ions at the Central Research Institute for Physics in Budapest started. Subsequently methods, scope and preparation tools were step-by-step extended and organized into a network. FunMatLab is presently an open-access research infrastructure (RI) accessible to all scientists, developers and students worldwide.

Major FunMatLab facilities include a molecular beam epitaxy (MBE) equipment, a chemical technology and isotope laboratory, a heavy-ion implanter, a Van de Graaff accelerator with ion-beam analysis (IBA), a Mössbauer laboratory with spectrometers of various detection methods and sample environments, a polarized-beam neutron reflectometer as well as an X-ray optics development and high-resolution X-ray spectroscopy (XANES, EXAFS, and XES) laboratory, and set-ups for femtosecond-resolved pump-probe laser spectroscopies. These latter include transient optical absorption, time-resolved fluorescence, and stimulated Raman scattering (fs-SRS). The X-ray and laser techniques were developed in the last decade using an ERC grant as well as the national excellence programmes Momentum, VEKOP and NKP.

### *Activities and services*

Proposals can be submitted any time and will be checked for feasibility first. In case of a positive outcome, financial, cooperation and intellectual property conditions will be negotiated in line with public and transparent rules. FunMatLab encourages accessing the facilities in smart-access mode, i.e. with mail-in samples and, if possible, remote control by the users from their home institutes or universities. FunMatLab offers sample preparation and analytical services that serve as precondition of accessing pan-European RIs like ESRF, ESS and the European XFEL. Most of the analytical methods are non-destructive preserving valuable samples, an important aspect for cultural heritage applications. X-ray and Mössbauer methods have chemical sensitivity, the pump-probe techniques unveil ultrafast molecular dynamics, Mössbauer spectroscopy and neutron reflectometry have magnetic sensitivity, etc. At the heart of materials innovation is an understanding of material structures from the atomic and microscopic scales upwards. Current research topics of groups recently using FunMatLab include studying ultrafast transitions in light-activated functional molecules, applying X-ray spectroscopy as probes with the final aim of developing smart materials of matching structure and function. Very recently, a project used, in a complex way, most of the FunMatLab facilities for fine-tuning magnetic quantum properties to be finally used for developing low-energy devices. In the future, FunMatLab facilities can be efficiently used for research related to various Horizon Europe missions, most notably to Mission 4 (climate-neutral and smart cities).







## Micro- and Nanotechnology Research Laboratory



Centre for  
Energy Research

### Host institution:

Centre for Energy Research (EK),  
Eötvös Loránd Research Network

### RI location:

Budapest KFKI Campus

### Partners:

Budapest University of Technology  
and Economics, Pázmány Péter  
Catholic University,  
Semmelweis University,  
Wigner Research Centre for Physics,  
Institute for Computer Science and  
Control, 77 Elektronika Ltd., BHE  
Bonn Hungary Electronics, Semilab  
Zrt., Diagnosticum Zrt., Knorr-Bremse

### International connections:

Philips Research, Senop, Anton  
Paar, Z-microsystems, VTT, FRK,  
Osypka, Moscow Nuclear  
Research University

### Available services:

MEMS/NEMS development,  
2D micropatterns  
thin film structures  
nanofabrication

### Website:

[www.biomems.hu](http://www.biomems.hu)  
[www.nems.hu](http://www.nems.hu)

### Person in charge:

Péter Fürjes, PhD – Microsystems  
[furjes.peter@energia.mta.hu](mailto:furjes.peter@energia.mta.hu)

### Contact:

Janos Volk, PhD – Nanosensors  
[volk.janos@energia.mta.hu](mailto:volk.janos@energia.mta.hu)

### Description of the research infrastructure

The main goal of Micro- and Nanotechnology Research Lab of Centre for Energy Research (Institute of Technical Physics and Materials Science) is to research and develop integrated microsensors, MEMS and BioMEMS systems and nanotechnology based devices (sensors and nanoelectronics).

### Major research topics:

- Micro- and nanoscale physical, chemical / biochemical sensors and systems
- Micro- and nanoelectromechanical systems (MEMS/NEMS)
- Autonomous wireless sensor networks
- Microfluidic, nanofluidic, Lab-on-a-Chip and Organ-on-Chip systems (BioMEMS) and their applications in Point-of-Care diagnostics devices
- Implantable microsystems
- Optoelectronic devices (IRLED)
- Novel functional materials and technologies
- Semiconductor nanodevices and quasi-one-dimensional nanostructures, integrated nanosensors

Unique infrastructure in Hungary. The high-tech microtechnology related fabrication and characterisation systems work in a class 10 cleanroom facility. The laboratory is dedicated for 3D processing of 3" and 4" Si / glass / polymer substrates with maximal resolution of 1µm, together with lithographic mask manufacturing. Electron beam lithography and focused ion beam (FIB) milling are also available with resolution of 20nm. The structural design and development are also supported by multi-domain Finite-Element Modelling (FEM), and process simulation. Wide spectra of characterisation techniques are also available: optical (fluorescent) and electron microscopy (SEM and EDS), atomic force microscopy (AFM), profilometry, optical and electrical measurements, electrochemical impedance spectroscopy, microfluidic characterisation, mechanical vibration and climate test chambers, UV / VIS / IR / FTIR spectroscopy, etc.

### Activities and services

The Lab collaborates with several Hungarian scientific centres to perform interdisciplinary research. We are participating in the National Quantum Technology Program (HunQuTech). Besides the scientific projects, the Lab offers technology development services, with industrial partners the higher technology readiness levels are also achievable.

The technological and scientific results are directly transferred into the higher education, represented in several lectures, laboratory practices, TDK, diploma and PhD works.

The infrastructure is open for academic and industrial partners to realize complex, purpose-designed microsystems, nanocircuits, as well as Lab-on-a-Chip devices.





# Aberration corrected transmission electron microscope



Centre for  
Energy Research

**Host institution:**

Centre for Energy Research (EK),  
Eötvös Loránd Research Network

**RI location:**

Budapest KFKI Campus

**Status:**

Fully operational, 2018-

**Partners:**

Wigner FK,  
ELTE, BME, SZTE,  
CsFK GGI  
Technoorg-Linda Kft

**International connections:**

Jülich FRZ, CNR Catania, Linköping  
University Sweden, IMR SAS  
Kassa, EagleBurgman  
Germany,

**Available services:**

FIB lamella preparation, Ar ion  
thinning, TEM and STEM imaging,  
EDS elemental mapping, structural  
data and structure models

**Website:**

[www.thinfilms.hu](http://www.thinfilms.hu)  
[https://www.mfa.kfki.hu/kutatas/  
projektek/vekop-themis/](https://www.mfa.kfki.hu/kutatas/projektek/vekop-themis/)

**Person in charge:**

Ákos Horváth, Director General of EK  
[horvath.akos@energia.mta.hu](mailto:horvath.akos@energia.mta.hu)

**Contact:**

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+3613922587  
[pecz.bela@energia.mta.hu](mailto:pecz.bela@energia.mta.hu)

## Description of the research infrastructure

Centre for Energy Research opened the first aberration corrected transmission electron microscopy laboratory of the country. The special microscope operating at 200 keV provides sub Angström (0.1 nanometer) resolution and opens new possibilities in scientific research and in research and development: in the investigation of semiconductors and ceramics, metals, 2D materials and other nanostructures.

**Available operation modes:**

- 200 kV, or 80 kV, the latter one for the investigation of beam sensitive materials
- TEM imaging mode at 200 kV with 0.07 nm resolution
- STEM scanning mode with 0.136 nm resolution
- Elemental mapping in STEM mode with 4 EDS detectors built in
- Z contrast imaging with STEM HAADF detector
- Electron diffraction and orientation maps on polycrystalline materials by own developed software

Further possibilities on other existing devices of the laboratory:

- FIB (Focussed Ion Beam) lamella preparation practically from any material
- Sample thinning by Ar ions
- Analytical electron microscopy with high angle tilting possibility
- Electron energy loss analysis (EELS)

This research infrastructure is operated by the Thin Film Physics Department, which has more than 50 years of experience in transmission electron microscopy.

## Activities and services

The new (Open) laboratory is used in the higher education at the PhD and MSc level. Open for academic partnership, international networking and also for the Hungarian industry. Partnership s offered in the development of electronic components, coatings and functional materials by providing results with short response time at the nanoscale. Could be useful for failure analysis and during the development of the prototypes of new scientific devices. For example the analysis of a coating on a piston ring is possible in the laboratory.





# Machine Vision and Optical Perception Laboratory

**Host institution:**

Institute for Computer Science and Control (SZTAKI), Eötvös Loránd Research Network

**RI location:**

Budapest

**Status:**

Operational

**International connections:**

Khronos Group

**Available services:**

Real-Time 3D, Virtual Reality, Mixed Reality

**Website:**

[//www.sztaki.hu/en/science/departments/mplab](http://www.sztaki.hu/en/science/departments/mplab)

**Person in charge:**

Tamás Szirányi  
sziranyi@sztaki.hu

### *Description of the research infrastructure*

Machine Vision and Optical perception laboratories have a wide range of imaging and display tools:

- Multi-camera motion tracking theatre, Thermal and night vision cameras, Hyperspectral cameras, Time of flight cameras
- Lidars: Velodyne-s for on-board traffic detection, fixed FARO for construction scanning
- Special Digital Holographic Microscope
- Cameras on UAV and UGV drones/robots
- ApertusVR: Industrial Virtual Reality laboratory

### *Activities and services*

High Definition Real-Time 3D Lidars: Velodyne HDL-64E and VLP-16 sensors with 360° field of view for obstacle detection and navigation for autonomous ground vehicles or UAVs. Applications are in perception tasks, 3D mobile data collection and 3D mapping solutions. The high precision fixed position FARO lidar is for construction scanning and 3D models for environment analysis; its HDR-camera assigns color and texture information to each 3D point.

Mixed reality smartglass: Microsoft HoloLens 2 is a holographic technology, providing an immersive and comfortable mixed reality experience, with precise hand and gaze tracking. ApertusVR: Industrial Virtual Reality Laboratory contains various virtual reality hardware, e.g. the Human-sized Immersive Virtual Reality Display which has been updated in 2016 containing more than ten different types of virtual reality tools. The hardware and the software facility of the ApertusVR were used in the HuNoRob, VisionAir, NeuroCogSpace, and Virtual Learning Factory projects.

Digital Holographic Microscopes: Color, monochromatic, and fluorescent digital holographic microscopes for transparent volumetric water, industrial liquid, or gas inspection are available. Detectibility from 1 micron, recognition from 10 micron. Hyperspectral cameras: 16 band high resolution hyperspectral camera and 4 band multispectral camera with sunshine sensor, both sensitive in the NIR range, used for remote sensing, navigation, smart-farming, conservation of natural habitats and rescue tasks.

Multi-camera motion tracking theatre: the Optitrack system enables the tracking of retroreflective markers with high precision and data rate.





# Nanolab (Electron Microscopy) at the University of Pannonia

nanolab

**Host institution:**

Research Institute of Biomolecular and Chemical Engineering, University of Pannonia

**RI location:**

Veszprém, UP campus

**Status:**

Fully operational, 2018-

**Partners:**

Faculty of Engineering, University of Pannonia

**International connections:**

**RIs:** ESTEEM3 (Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons, Jülich; Jožef Stefan Institute, Ljubljana)

**Research organizations:**

University of Vienna, University of Cambridge, University of Warsaw, CEA Cadarache

**Available services:**

Scanning transmission electron microscopy (Thermo Fisher Talos F200X) with Super-X EDS system and electron tomography for the structural, compositional and morphological analysis of materials on the nm scale; scanning electron microscopy (Apreo LoVac) with EDS and EBSD; sample preparation for TEM (RMC Powertome ultramicrotome and Technoorg Linda ion mill)

**Website:**

<https://nanolab.uni-pannon.hu/en/>

**Person in charge:**

Mihály Pósfai, Professor, mihaly.posfai@gmail.com

**Contact:**

Péter Pekker, lab manager, pekkerpeter@gmail.com

## *Description of the research infrastructure*

Nanolab is an electron microscopy centre established in 2018 at the University of Pannonia, a medium-sized university with a strong research performance in chemistry, nanotechnology, material, earth and environmental sciences. Our Talos F200X G2 electron microscope can be operated in both transmission (TEM) and scanning transmission (STEM) modes. Its Super-X energy-dispersive X-ray system (EDS) can be used for the fast and quantitative mapping of elemental compositions on the subnanometer scale. Electron tomography is also available for the 3D reconstruction of both morphologies and compositions. Stable, noise-free conditions for the Talos are ensured by a custom-designed building, resulting in 1.35 Å STEM resolution and 0.7 Å TEM information limit. TEM sample preparation equipments include an ion milling machine and an ultramicrotome. The other major instrument of the centre is an Apreo LoVac scanning electron microscope (SEM), equipped with EDS and EBSD (electron back-scattered diffraction) systems, for the analysis of elemental compositions and for the mapping of the crystallographic texture of specimens, respectively.

## *Activities and services*

The electron microscopes are used by both Nanolab staff and external, trained users, both from within and outside of the University of Pannonia. We welcome users from other universities, research institutes and industry as well. Since the installation of the lab we have had a stream of visiting users with a large variety of research programs, both in physical and life sciences (for current projects and conditions of lab use, please see our webpage).

In addition to the service provided to the wider research community and industry, Nanolab staff pursue their own research agenda. Our research interests encompass diverse topics in environmental mineralogy, including the precipitation of carbonate minerals both in natural and artificial systems, the special properties and formation mechanisms of biominerals, the development of biomimetic filamentous magnetic nanostructures, and the characterization of individual atmospheric aerosol particles for understanding their effects on climate and health.



# Atomki Tandetron Laboratory (ATL)

**Host institution:**

Institute for Nuclear Research  
(Atomki)  
Eötvös Loránd Research Network

**RI location:**

Debrecen

**Status:**

Fully operational, 2018-

**Partners:**

DE, Wigner FK, ELTE, MFA, BME

**International connections:**

HZDR, GSI, INFN, CNRS, CERN,  
University of Surrey, University of  
Singapore, Jozef Stefan Institute,  
Ruder Bošković Institute

**RIs and research organizations:**

RADIATE, EUROPLANET,  
IPERION-HS, E-RIHS,

**Available services:****Website:**

<https://www.atomki.hu/en/>  
<https://tandetron.atomki.hu/leaflet.pdf>

**Person in charge:**

Dr. Zsolt Dombrádi, director  
[director@atomki.hu](mailto:director@atomki.hu)

**Contact:**

Dr. István Rajta, head of the  
laboratory  
[rajta@atomki.hu](mailto:rajta@atomki.hu)

**Open access:**

Services are available in an open  
access scheme, through the PAC:  
<https://www.atomki.hu/en/pac>

### *Description of the research infrastructure*

The Atomki Accelerator Centre incorporates several low-energy charged-particle accelerators, which offer the possibility of choosing ions with various charge states, energies and beam intensities.

The Tandetron accelerator was manufactured by High Voltage Engineering Europa B.V. There are three ion sources attached to the accelerator, these are capable of generating high intensity and brightness of proton, helium and various heavy ion beams. On the high-energy end a 90 degree analysing magnet has been deployed, as the result of which high energy stability can be reached. The switcher magnet has 9 exit ports, several different endstations are already built, some are under construction (as of June 2020). Typical beam parameters: 200 keV – 4 MeV protons from nA to 200  $\mu$ A, 200 keV – 6 MeV helium from nA to 40  $\mu$ A, and up to ~10  $\mu$ A of various heavy ions (energy depending on charge state). The project was funded by the infrastructure grants of the Hungarian Academy of Sciences, and the GINOP (Economic Development and Innovation Operational Program) grant: GINOP-2.3.3-15-2016-00005.

### *Activities and services*

The high-quality ion beams provided by the accelerator can be used in a wide range of research projects both in basic and applied sciences. The former includes, e.g., atomic physics, material science and nuclear astrophysics, while the latter range from medical to atmospheric science and archaeology. In nuclear astrophysics, processes going on in stars and supernovae typically correspond to the energy range available at the Tandetron. In an ice chamber for astrochemistry, ion induced chemical processes are studied above 10K temperature in frozen gas mixtures. It serves as a transnational access facility of the EUROPLANET 2024 RI project. For fundamental nuclear physics, an updated setup is installed for extending the investigations of the anomaly observed in the  $e^+e^-$  angular correlation. The installation of a complex ion beam analytical (IBA) endstation allowed for the application of a wide range of ion beam analytical methods. IBA techniques are widely used for the structural and compositional characterization of materials. Additionally, IBA methods can also be applied coupled to a nuclear microprobe, and on the newly developed nanoprobe, which allow lateral imaging of the samples. Both of them can be applied in various IBA tasks and proton beam writing (PBW), which is a 3-dimensional direct write lithography method.



# ZalaZONE Automotive Proving Ground

**Host institution:**

ZalaZONE Automotive Proving Ground

**RI location:**

Zalaegerszeg, West Hungary

**Status:**

Partially operational

**International connections:**

AVL Hungary, Ericsson, Furukawa Electric Group, Inventure Automotive, Knorr-Bremse Hungary, Magyar Közút Nonprofit Ltd., Mould-Tech Ltd., Robert Bosch Ltd., eMobi Ltd.

**Research organizations:**

Austrian Institute of Technology, EU Joint Research Center, Fachhochschule Campus Wien, HW Dresden, TU Graz, TU Wie, Linz Center of Mechatronics, Virtual Vehicle, Pannon University, Széchenyi István University, Bay Zoltán Research Institution

**Website:**

[www.zalazone.hu](http://www.zalazone.hu)

**Person in charge:**

Dr. András Háry managing director  
[apz@apz.hu](mailto:apz@apz.hu)

**Contact:**

Dr. Zsolt Szalay R&I manager  
[zsolt.szalay@auto.bme.hu](mailto:zsolt.szalay@auto.bme.hu)

### *Description of the research infrastructure*

The aim of the testing grounds is to provide competitive testing and validation infrastructure the industry, considering the spread of autonomous and electric vehicles as well as newly developing testing requirements. This will be served by the multilevel validation environment addressing the European market and many of its automotive segments.

Vision: „Creating a comprehensive testing environment for vehicles and communication technologies of the future, multilevel development testing possibilities ranging from prototype to completed serial product testing”

### *Activities and services*

The co-operation of education and education-based researches is a main element of the project. The automotive proving ground has a key importance as a complex and integrated Research & Development facility which supports customers and experimental developments. The ZalaZONE Research and Technology Centre is located just beside the proving ground, in a very close relation with its activities. It was opened last year and functions as an incubator/accelerator for SMEs and start-ups as well as university based R&D centre, for Hungarian, regional, European, and global university and industrial partners, where cooperation and collaboration between enterprises and universities are strategically key focus points. The practical dual training program for high school students, where students can acquire the theoretical knowledge, they have received in higher education contributes to the success of the project.

Tests on the interaction of autonomous vehicles and drones may soon begin at the drone testing and development centre to be established next to ZalaZONE in the near future.



# Atomki Laboratory for Heritage Science (HSLab)



**Host institution:**

Institute for Nuclear Research (Atomki),  
Eötvös Loránd Research Network

**RI location:**

Debrecen

**Status:**

Fully operational, 2019-

**Partners:**

Atomki Tandetron Laboratory, carbon dating facility, University of Debrecen

**International connections:**

RIs: E-RIHS

**Research organizations:** Partner in

EU projects (H2020): IPERION HS, ERIHS PP

**Available services:**

material characterization of art and archaeological objects; other interdisciplinary applications

**Website:**

<https://hslab.atomki.hu>

**Person in charge:**

Zsolt Dombrádi, director of Atomki  
[director@atomki.hu](mailto:director@atomki.hu)

**Contact:**

Zita Szikszai, Head of Laboratory  
[szikszai.zita@atomki.hu](mailto:szikszai.zita@atomki.hu)

## *Description of the research infrastructure*

The Laboratory for Heritage Science was established in 2019 to promote research in the field of cultural and natural heritage in collaboration with national and international partners. The laboratory is based on the decades-long expertise in non-destructive material characterisation using focused ion beams provided by the accelerator facility of the institution. Thanks to an infrastructure development project, an assortment of state-of-the-art analytical and imaging devices could be procured, which enables more complex examinations in a wide range of scales.

## *Activities and services*

HSLab conducts ion beam analytical investigations to determine the concentration and distribution of elements both in vacuum and in-air (for larger or sensitive artefacts) with high lateral resolution. The laboratory provides trans-national access to the ion beam analytical facility within the EU H2020 IPERION HS (Integrated Platform for the European Research Infrastructure on Heritage Science) programme, continuing from the former CHARISMA and IPERION CH programmes.

Elemental analysis and mapping is also carried out with a micro-XRF device. Besides more traditional techniques, optical imaging is conducted with a digital 3D microscope which yields quantitative information about the structure of the objects in addition to the excellent image quality. A variable pressure scanning electron microscope (SEM) with analytical modalities is also available. This instrumentation is fitted with a Raman microscope and is able to function as an integrated SEM-Raman microscope. All these techniques are non-destructive and are offered for interdisciplinary research.

Projects from national partners (museums, universities, research institutions) are carried out within various frameworks, more recently within the E-RIHS.hu initiative. ERIHS.hu is the national consortium led by Atomki, with the participation of the Centre for Energy Research, the Wigner Research Centre for Physics, and the Hungarian National Museum, representing Hungary in the preparatory phase of the European Infrastructure for Heritage Science (E-RIHS).

HSLab is also active in higher education and science promotion.





# HunCLARIN

CLARIN



**Host institution:**

Research Institute for Linguistics

**RI location:**

Budapest, Hungary

**Status:**

Partially operational

**Partners:**

Research Institute for Linguistics (coordinator)  
Institute for Computer Science and Control, Hungarian Academy of Sciences  
MOKK Centre for Media Research and Education, Budapest University of Technology and Economics  
Department of Telecommunications and Media Informatics, Budapest University of Technology and Economics  
University of Szeged  
University of Debrecen  
MorphoLogic Ltd  
Pázmány Péter Catholic University

**International connections:**

ESFRI CLARIN-ERIC

**RIs:** 42 RIs (Corpora: 23

Language technology tools: 19)

**Available services:**

<http://clarin.hu/>

**Website:**

<http://clarin.hu/>

**Person in charge:**

Tamás Váradi  
[varadi.tamas@nytud.hu](mailto:varadi.tamas@nytud.hu)

### Description of the research infrastructure

CLARIN ERIC (Common Language Resources and Technology Infrastructure) is a European network of research infrastructures that makes digital language databases and language processing tools available to researchers in the humanities and social sciences.

HUN-CLARIN, in line with the overall CLARIN mission, considers it a high priority to support humanities and social science research with suitable language technologies and language resources.

The current 8 members of HunCLARIN all represent leading centres of Hungarian language and speech processing. The coordinator is the Research Institute of Linguistics. The language technology resources (eg monolingual, multilingual and thematic corpora) and tools (eg morphological analysts) developed by the partners make it possible, for example, to analyze the content of large corpora (eg from a given historical age), or automatic coding of psychological message contents.

### Activities and services

HUN-CLARIN Roadshows: HUN-CLARIN devised the concept of a Roadshow series that is based on the idea of proactively (and literally) bringing language technology to where humanities research is actually done, namely, to Hungarian universities. The other key concept behind the Roadshows is that instead of a one-sided evangelisation of language technology, the workshop should mobilise and showcase local initiatives (workshops so far: Szeged, Debrecen, Pécs).

Web-service of key Hungarian resources and tools: e-magyar (e-Hungarian). The toolchain was developed in 2016. The rationale for it was based on a clear vision of an open, modular, extendable and easy-to-use pipeline for Hungarian, which was suitable for non-specialists and developers alike.

Corpora: Multimodal HuComTech Corpus, Hungarian Webcorpus, Hungarian National Corpus, 4lang, Hungarian Generative Diachronic Syntax etc.  
Language technology tools: Hunalign, Hunmorph, HunToken, MetaMorpho, Hungarian Nooj, Mazsola, magyarulanc etc.  
regional, European, and global university and industrial partners, where cooperation and collaboration between enterprises and universities are strategically key focus points. The practical dual training program for high school students, where students can acquire the theoretical knowledge, they have received in higher education contributes to the success of the project.  
Tests on the interaction of autonomous vehicles and drones may soon begin at the drone testing and development centre to be established next to ZalaZONE in the near future.







# Hungarian National Supercomputing Service and Competence Centre



### Host institution:

Governmental Agency for IT Development

### RI location:

5 KIFU HPC Centres in Hungary (Budapest, Debrecen, Miskolc, Pécs, Szeged)

### Status:

fully operational in current setup since 2015 (established in 2003)

### Partners:

about 31 research institutes (71 sites); 44 universities (118 sites); 5947 primary and secondary schools; 420 libraries, museums and other public collections (503 sites).

### International connections:

RIs: GEANT, PRACE, EOSC, EUROHPC

### Available services:

Provide access for the related community to a wide range of national and international e-infrastructure services, including: high performance computing and data processing and data processing consulting services for research communities

### Website:

<https://kifu.gov.hu>

### Person in charge:

Krisztián Kongó vice president of KIFÜ

### Contact:

János Mohácsi, Head of International R&D, [intproject@kifu.hu](mailto:intproject@kifu.hu)

### Description of the research infrastructure

KIFÜ's e-infrastructure for research and education complies with European standards and demands, by featuring a complex portfolio of services, with full connection to the approx. 40 European NRENs (National Research and Education Network e-infrastructures), and indirect connection to an additional approx. 60 non-European NRENs. It covers all internationally accepted functions of ICT-based communication and cooperation, information processing and data storage, by providing all research areas with e-infrastructure.

The e-infrastructure of KIFÜ, as part of the GÉANT infrastructure (the European backbone network connecting the NRENs and supporting the ICT infrastructure for research and education in Europe) and of the PRACE and EUROHPC infrastructure (the pan-European supercomputing infrastructures), provides stable and full-featured connection and cooperation possibilities. It enables access to all research institutions and researchers in Europe, including all major European research infrastructures. Multimedia information management, resource and service virtualisation, federated identification and access management, specific educational and research support service are among the tools built in the system for a better user experience.

### Activities and services

During the 19 years' experience laid down in supercomputing and high volume, distributed data storage the NIIF Program augmented a large piece of distributed scientific infrastructure and corresponding support services. They are broadly used for contemporary scientific simulations and data processing. In these services the whole innovation chain is reinforced, from the high-level algorithmic and software development support to the final exploitation of the scientific data produced.

As of 2020, KIFU offers computational services to thousands of domestic users through the HPC excellence centre. The over 448 Tflops (8900 CPU+GPU cores) capacity and 8 PB hard drive storage, accessible to researchers in the country and in the region will be extended in the next year to about 5 PFlops computational capacity, available to the entire domestic research community.

The national HPC Competence Centre operated by KIFU is providing high level technical support for the users for efficient usage of the HPC tools and services, as well as it aims to spread the HPC knowledge in the community by organizing trainings, education and events. It is also going to foster the cooperation between industrial partners and academia and it is actively seeking the ways for the usage of HPC in development and innovation





# Internet of Living Things (IoLT)



## INTERNET OF LIVING THINGS

### Host institution:

Department of Software Engineering,  
University of Szeged

### RI location:

Dugonics tér 13, 6720 Szeged,  
Hungary

### Status:

Fully operational, 2015

### Partners:

Biological Research Centre, Eötvös  
Loránd Research Network; Research  
Group on Artificial Intelligence

### International connections:

Samsung, ARM, Intel, Nokia, EQALM

RIs: ELI-ALPS

**Research organizations:** Liverpool  
John Moores University

### Available services:

Open source software development,  
JerryScript adaptation, domain  
adaptation. Static code analysis.  
IoT-Fog-Cloud simulation. Analysis  
of medical texts and images  
(AI). Telemedicine application  
development.

### Website:

<https://sed.inf.u-szeged.hu/iolt/>

### Person in charge:

Tibor Gyimóthy, head of research  
Rudolf Ferenc, head of department

### Contact:

Attilia Kertész (IoTCloud group),  
keratt@inf.u-szeged.hu  
Ákos Kiss (JerryScript group),  
Vilmos Bilicki (Included group)

## Description of the research infrastructure

Open source IoLT software platform that allows even non-IT researchers to develop biological, medical, and also conventional IoT applications. The platform enables researchers of any discipline to develop and execute IoT applications by providing easy-to-use programming interfaces and tool sets. The platform supports a wide range of devices in general, and ultra-low-resource, ultra-cheap IoT devices in particular. Available components: JavaScript interpreter developed for heavily constrained IoT devices (JerryScript); IoT development environment for rapid application development; tools for software quality assurance including static code analysis, source code quality and vulnerability checks; device drivers, communications, IoT cloud infrastructure and simulators; algorithms for ensuring data safety and security.

## Activities and services

Development of the platform is continuous, which includes the adaptation of the core JerryScript execution environment to application-specific peripherals. The development of IoLT applications is facilitated through the high-level programming of ultra-low-resource sensors for adaptive data collection and processing. Simulation tools are developed for investigating the efficient and secure management of IoT applications in fog and cloud systems. Advanced AI tools are available, e.g., for medical applications and natural language processing.

The platform enables the assessment of the impact of environmental factors determining the growth and stress reactions on individual plants. In medical practice it supports actigraphic research for identifying new ultradian and slower periodic and stochastic components in human physical activity patterns and establishing their correlation to physical conditions, activities, and certain psychiatric disorders. Devices running the platform can greatly increase the effectiveness of work on cell cultures by facilitating the testing of potential active substances. To increase the efficiency of personalised therapies, the platform can aid the analysis of microscopic images and automatic classification. The Included services provided on the top of the IoLT platform support the whole value chain of the clinical trials, including study design, ISO 13845 certified telemedicine environment with integrated sensors, workflows, big data processing, and evaluation.





# Wigner Datacenter



### Host institution:

Wigner Research Centre for Physics

### RI location:

Budapest, KFKI campus

### Status:

Fully operational, 2012-

### Partners:

Ministry of Innovation and Technology (ITM), National Research, Development and Innovation Office (NKFIH), Eötvös Loránd Research Network (ELKH), KIFÜ, HRDA, Institute for Computer Science and Control (SZTAKI)

### International connections:

CERN, ELI, EGO VIRGO, GEANT, EOSC, RDA

RIs: ELI-ALPS

### Research organizations:

Liverpool John Moores University

### Available services:

Missions in data science with a wide scope, ELKH Cloud, Wigner Cloud, GPU Days, HEPTECH AIME

### Website:

<https://wignerdc.wigner.hu/>  
<https://gpu.wigner.mta.hu/en/>  
<https://gpuday.hu/>

### Person in charge:

Peter Levai, Director General of Wigner RCP, [levai.peter@wigner.hu](mailto:levai.peter@wigner.hu)

### Contact:

Jozsef Kadlecsek, Head of the Wigner Datacenter, [kadlecsek.jozsef@wigner.hu](mailto:kadlecsek.jozsef@wigner.hu)  
Gergely G. Barnaföldi, Wigner GPU Laboratory, [barnafoldi.gergely@wigner.hu](mailto:barnafoldi.gergely@wigner.hu)

## Description of the research infrastructure

The Wigner Datacenter is one of the most modern information technology (IT) infrastructure in Hungary and in Central Europe. At the same time it is one of the leading IT infrastructures supporting research activities. The Datacenter was built in 2012 with the support of the Ministry of National Development; a project fitting into Europe's Digital Agenda and the Digital Renewal Action Plan. It started to work in 2013 as the CERN's additional Tier-0 computer centre with 4 MW capacity. The original CERN project finished at the end of 2019, however part of the existing infrastructure has been reorganized into the ALICE Analysing Facility, which is under development now. In parallel with the CERN project, the Wigner DC started to develop the Wigner Cloud (2015) and the ELKH Cloud (2016), which was named earlier as MTA Cloud. These cloud services offer a high quality IT support to national and regional research projects, for example the National Brain Program and the National Quantum Technology Program. Wigner Cloud supports further international research projects like ELI, Virgo, and several H2020 projects. The twin modul of the ELKH Cloud can be found at the Institute for Computer Science and Control (SZTAKI). The main users of the clouds are researchers from particle physics, gravitation research, artificial and intelligent materials, brain research, bioinformatics, and computational sciences. These areas involve around 800 potential users. During last 3 years more than 100 projects had been accomplished on the clouds.

## Activities and services

The ELKH Cloud and Wigner Cloud together give 1368 virtual CPU core, 527 TB disc space, and 1.6 PB capacity of tape unit for the service of the Hungarian and regional research projects. In 2018 Wigner Datacenter extended the Cloud service with GPU units, which are 8 NVIDIA Tesla V100 unit with capacity 62 Teraflop (double precision) and 1 Petaflop (for tensor calculations). For middle of 2021 these capacities will be tripled by a new development plan, which is under completion. In parallel, locally a CERN TIER-2 station runs with 1000 CPU-core (2000 virtual core, 15 000 HS06) and 1 PB storage unit. Furthermore, the Wigner GPU Laboratory offers opportunity to run special programs, to discuss massive-parallel computing problems and helps to start coding/programming activities in educational, industrial and research topics. Workshops and focused trainings are organized regularly, building the bridge between state-of-the-art IT technologies, programmers, and researchers of many fields. Furthermore, the local GPU Laboratory offers opportunity to run special programs, to discuss GPU-related problems and helps to start GPU-based activities in educational, industrial and research topics. Workshops and focused trainings are organized regularly.





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