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MINISTRY OF EDUCATION
AND RESEARCH



Eesti Teadusagentuur
Estonian Research Council

ESTONIAN RESEARCH INFRASTRUCTURE ROADMAP 2019





Compilers: Priit Tamm (Estonian Research Council), Toivo Rääm (The Ministry of Education and Research)
Translation: Scriba OÜ
Cover photo: Sven Tupits
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Definition of research infrastructure

Research infrastructures are tools (laboratories, equipment, devices, collections, archives, structured information or a body thereof) and the conditions, expertise, methods, materials, activities and services related thereto, which are used to create, transfer, exchange and/or preserve new knowledge gained through research and development. Research infrastructures can be single-sited (e.g., telescopes and synchrotrons), distributed (e.g., a networks of biobanks), and can have central/shared or virtual services (e.g., databases and archives) that end users can access from their workplace.

Purpose of roadmap

A roadmap is a long-term (with the perspective of 10–20 years) planning tool that contains a list of new research infrastructure units of national importance or those that require updating. The infrastructures included in the roadmap can be physical objects and network structures as well as memberships in international research infrastructure organisations. The roadmap is supplemented regularly (in a cycle of 3–4 years) in order to take changing needs and opportunities into account. Including a research infrastructure in the roadmap does not constitute a funding decision or list objects in priority order. Instead, it serves as input for future funding decisions.

The list of objects of the Estonian Research Infrastructure Roadmap is approved as an updated annex to the implementation plan for 2016–2020 of the Estonian Research and Development and Innovation Strategy 2014–2020 *Knowledge-based Estonia* with the order of the Government of the Republic No. 43 from 14 February 2019.

Dear readers

The publication you are holding in your hands is the Estonian Research Infrastructure Roadmap. It is a gateway to the research world of Estonia and also the whole of Europe. In addition to descriptions and contact details, the publication includes information about Estonia's current and planned memberships in major European research infrastructures.

Conducting excellent research requires access to varied research environments. Nowadays, creating suitable conditions in Estonia is not sufficient: above all, we need international cooperation. Establishing new shared infrastructures, either single-sited or distributed, is becoming increasingly more worthwhile, cost-effective and provides new research opportunities. The sustainability of resource-heavy research environments is becoming ever more relevant, which is why there is a need to foster joint activities in both Estonia and Europe.

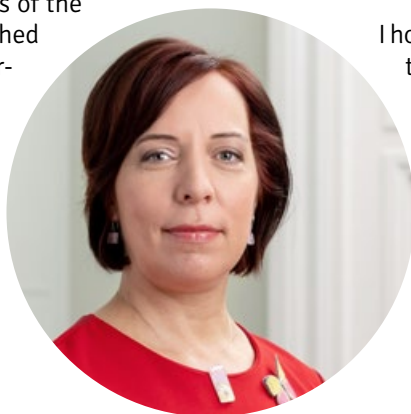
The proposal of the roadmap was made by the Research Infrastructure Committee of the Estonian Research Council, who was joined by the members of the Estonian Academy of Sciences, distinguished university researchers, officials from different state institutions and experts from the private sector. The committee's proposal was supported by the Research Policy Committee of the Ministry of Education and Research and the Research and Development Council. As you can see, the cooperation has been fruitful.

The roadmap makes it easier to consider

national priorities in making funding decisions. Estonia supported the development of roadmap objects already in the previous European Union budgetary period. This period, 2014–2020, an investment schedule with a total volume of 20.9 million euros was prepared on the basis of the roadmap, 26.3 million euros of which involved the European Union's structural support. The government allocated 20.1 million euros of the total volume for investments already in 2016. The rest of the funds are allocated on the basis of the second investment proposal collection round, in which new objects that have not yet received funding will participate.

In a world that is rapidly becoming more complex, research, development and innovation are the pillars that support the development of society. As a result, we can improve economic productivity and living standards while also clearly increasing quality of life and well-being. The welfare of the Estonian state, language, education and culture is directly linked to research and development, for which researchers require excellent working conditions.

I hope that this roadmap offers useful information to all readers and gives ideas for further constructive research activity.



Mailis Reps

Minister of Education and Research

Photo: The Ministry of Education and Research

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Introduction

This *Estonian Research Infrastructure Roadmap 2019* is already the third edition of the publication. Over the previous eight years, the roadmap has become an integral part of the work of both researchers and national officials as a long-term strategic planning tool for large research infrastructures of national importance. The roadmap is a multi-ranking list of research infrastructures that have great impact in Estonia. The list does not constitute a funding decision. Instead, it serves as important input for future strategic decision-making, incl. funding decisions.

Following an inquiry by the Ministry of Education and Research, at the end of 2017, the Estonian Research Council (ETAg) was given the task to analyse the activities of existing roadmap objects, make proposals for adding possible new objects as well as advise in questions related to research infrastructures. To this end, the Research Infrastructure Committee consisting of representatives of the state, business and academic sector, was formed and established with the directive of the Director General of the ETAg No. 1.1-4/18/16 of 12 February 2018¹.

The committee's work is based on *Updating of the Estonian Research Infrastructure Roadmap 2018*², a document prepared by the ETAg and approved by the committee. This served as a basis for compiling forms for both interim reports and new infrastructure proposals, which were partially prefilled with existing data. This was driven by the wish to burden the persons responsible for submitting interim reports and new infrastructure proposals as little as possible and to accommodate different forms of infrastructure. The forms had to take into account the specificities of new and operating objects, but also participation in the objects of the European Strategy Forum on Research Infrastructures (ESFRI) and other international research infrastructures, the possible membership in which is decided on the national level (by the Estonian government or the *Riigikogu*). The roadmap's activities and history are explained in detail in the introduction to the *Estonian Research Infrastructure Roadmap 2014*³, which addresses the results of the previous round of the roadmap.

By the deadline (5 May 2018), the committee received interim reports from all current 18 roadmap infrastructure objects and 15 new infrastructure proposals, eight of which expressed the wish to join an ESFRI roadmap object or another international research infrastructure organisation. Each interim report and new infrastructure proposal was assessed by two experts from the committee, one of whom served as the reporter at the committee's assessment

meeting, and also prepared a written report on the basis of the assessment instructions. Additionally, all members of the committee had to review all interim reports and new infrastructure proposals and provide a motivated assessment on whether to keep or include something in the roadmap. All of the aforementioned expert assessments were sent to the members of the committee before the start of the meeting. All roadmap objects were discussed individually and there were separate meetings for interim reports and new infrastructure proposals. The questions that remained undecided at discussions were addressed to the submitters of interim reports and new infrastructure proposals in writing, asking them to reply either in writing or by making a presentation (in the case of five objects) at the third meeting of the committee. Additionally, several ministries who had submitted supporting letters with regard to applications or reports, which did not include any information about the nature of the aid and/or possible (co-)funding, were sent a request to specify these aspects. The committee made a decision on the list of interim reports and the roadmap after the aforementioned discussions, analysing the written replies and listening to the presentations. The committee submitted their roadmap updating proposals to the ETAg.

The research infrastructures included in the roadmap are very varied when it comes to their field, funding, size and duration. From the very beginning when the ESFRI roadmap was first compiled in 2006, this measure has been followed and supplemented in most European Union countries. The main objective of the roadmap is to use additional measures to support the establishment of large research infrastructures of national importance. Thus, the roadmap is a list that is updated and supplemented over the years. The success of the roadmap's research infrastructure is reflected in the efficient launch of research-heavy activity of national importance. As in other fields, the establishment and deployment of a research infrastructure differs from its development and management. It is clear that in many cases, there is a need to ensure the constant budgetary (co-) funding of research infrastructures of national importance that have successfully completed the establishment phase. Project-based long-term management of such objects on similar grounds with newly established research infrastructures would be bureaucratic, illogical and unsustainable. Instead of making our research community (whose human resources are limited) somewhat artificially combine the same people and activities to correspond to the requirements of new projects, we should open more doors to the creativity of

1 <http://www.etag.ee/wp-content/uploads/2018/02/juhatus-k%C3%A4skkiri.pdf>, <http://www.etag.ee/wp-content/uploads/2018/05/juhatus-k%C3%A4skkiri-muudetud.pdf>

2 <http://www.etag.ee/wp-content/uploads/2018/05/Teekaart-2018-hindamisprotsess.docx> (in Estonian)

3 <http://www.etag.ee/wp-content/uploads/2013/05/Eesti-teadustaristute-teekaart.pdf>

researchers who have already proven themselves, ensuring a stable support to this end. The commission did submit corresponding proposals with regard to implemented roadmap objects that have completed or are soon to complete the establishment phase. It must be stressed that unlike failed objects, implemented research infrastructures are not removed from the roadmap. Their thematic differentiation from newly established infrastructures is, however, justified, also so as to avoid the accumulative expansion of the list. The ESFRI has created an additional list of so-called landmarks for all objects that have been included in the roadmap for ten years, on the presumption that during this period, a research infrastructure has been either successfully established and is active or failed and does not consequently belong among the landmarks. The committee recommended research policy makers to adopt an analogous system in Estonia and this has already been initiated. Three research institutions were attributed roadmap object status—the title of Estonian research infrastructure landmark—with the decision of the Estonian government, which approved the Estonian research infrastructure roadmap. However, the title of a landmark is certainly not sufficient, a support scheme to ensure the sustainability of their activities must be also created.

The research infrastructures analysed by the committee covered very different fields of research and there were no vast differences in terms of the field-based distribution. There has also been progress with regard to the inclusion of more varied research centres. The number of applications and level of reporting differed object by object. Objects with clear objectives that involve the best competence in Estonia and create straightforward additional value through the establishment of an infrastructure are at one end of this spectrum. The objects at the other end of this distribution stand out by their inclusion of top-level researchers, but the additional value created by this remains scarce or incomprehensible in the context of roadmap infrastructure—some applications are too general and focus rather on the wish to further develop the standalone activities of the participating research groups, i.e. applicants find that each partner should get something and they talk of cooperation without developing common ground. There is also room for improvement in developing actual internal and interinstitutional cooperation and reducing duplication. It would be naïve to hope that inclusion in the roadmap is the magic wand that reduces internal institutional duplication and improves the quality of cooperation. Our excessive share of project-based activities and the insufficiency of various funding instruments in the development of certain fields or solving research problems are the main reasons why different infrastructure proposals submitted to the

roadmap are in some cases compiled by the same “band members” to play rather similar “tunes”. Such a situation is a needless burden to researchers, experts and funders, also hindering top actors in their activities.

The committee made its decisions based on the state’s capacity and interests, the scope of the nationwide influence of different projects, and the actual size of the budget as well as the research community as a whole. Mainly in the case of very expensive infrastructure objects, we found there was a need for a thorough analysis of the impact and economic feasibility regarding the requested or necessary funding volumes.

The roadmap forms allowed adding support letters from state institutions, organisations and companies to advocate for the necessity of infrastructure objects. This possibility was used widely, but sometimes only to fulfil formal requirements. Even though most senders of support letters considered the research infrastructure in question very important and useful to them, the majority found it impossible to make a real contribution, incl. finance the cause even symbolically. If we leave one ministry’s conditional wish to find co-funding aside, no ministries of the Republic of Estonia who sent a support letter offered a specific financial contribution to a roadmap object despite the ETAg’s inquiries. This certainly provides food for thought to those who wish to take real steps and develop a research-based economy that supports the improvement of the country’s living standards and creates greater additional value.

Even though the committee didn’t base their discussions, assessments and decisions on the objects’ affiliation in terms of fields of research, this Estonian Research Infrastructure Roadmap provides an overview of objects in the roadmap list by fields, which are selected similarly to the distribution of the ESFRI roadmap in order to compare European and Estonian infrastructures.

All in all, it is great to see that the roadmap’s eight years of activity in providing research infrastructures with additional funding from European Union structural funds has produced tangible results, facilitated cooperation and improved competitiveness in both research and economy and opened up new international opportunities for Estonia. The Research Infrastructure Committee hopes that the roadmap, related discussions and the positions of the committee help to increase the country’s competitiveness and develop research-intensive economy.



Kristjan Haller
Chairman of the Research
Infrastructure Committee

Photo: University of Tartu

Research Infrastructure Committee

Established with the decree of the Director General of the Estonian Research Council No. 1.1-4/18/16 from 12 February 2018 (amended with the decree of the Director General No. 1.1-4/18/51 from 11 May 2018):

Kristjan Haller	Chairman of Committee
Ene Ergma	Estonian Academy of Sciences, Academician
Jüri Engelbrecht	Estonian Academy of Sciences, Academician
Urmas Varblane	Estonian Academy of Sciences, Academician
Joel Starkopf	University of Tartu, Professor
Tõnis Timmusk	Tallinn University of Technology, Professor
Martin Eessalu	Ministry of Education and Research, Chief Expert of Research Policy Department
Toivo Räim	Ministry of Education and Research, Adviser of Research Policy Department
Kaupo Reede	Ministry of Economic Affairs and Communications, Director of Economic Development Department
Erle Rikmann	Ministry of Social Affairs, Research Adviser
Henry Kattago	Government Office, Strategy Director
Krista Aru	Member of the <i>Riigikogu</i>
Oliver Väärtnõu	AS Cybernetica, Chairman of Management Board
Indrek Tammela	Finsight Oy, CEO

The tasks of the Research Infrastructure Committee are to:

- advise the Estonian Research Council in questions related to research infrastructures;
- participate in updating the Estonian Research Infrastructure Roadmap;
- analyse the activities of existing roadmap objects and new roadmap applications;
- make proposals to the Estonian Research Council to update the roadmap.



Natural Sciences



Estonian Environmental Observatory

Acronym: KKobs

Lead institution: University of Tartu

Partner institutions: Estonian University of Life Sciences, Tallinn University of Technology, Tallinn University

Contact person: Leho Ainsaar, leho.ainsaar@ut.ee

Website: kkobs.ut.ee

The Estonian Environmental Observatory is an integrated network of experimental environment stations developed jointly by Estonian research institutions, which covers three main fields of environmental studies: 1) atmosphere and climate studies, 2) biodiversity studies and 3) marine environment studies. The network of experimental stations monitors and engages in the experimental analysis of wild-life (flora and fauna, plants, fish and other aquatic biota) and the state of their living environment (atmosphere, sea, inland water bodies and soil). The key tasks of the environmental observatory are to analyse the exchange of energy and matter between atmosphere and biosphere, including marine ecosystems, questions related to the adaptation of terrestrial and aquatic ecosystems to global changes, above all changes in biodiversity and bioproductivity. The observatory combines different studies of sea and lake water, environment at the bottom of water bodies and measurements of the properties of atmosphere above seas (incl. automated stations and remote monitoring) into a unified information processing and scientific analysis network.

The Estonian Environmental Observatory's experimental stations are located in different natural environments in land areas, inland water bodies and coastal marine areas. The Järvselja cluster of experimental and measurement stations includes a station for measuring ecosystem-atmosphere relation (SMEAR) developed at the Estonian University of Life Sciences, a related University of Tartu (UT) Institute of Physics laboratory of aerosols and the UT Tõravere Observatory spectrometry measurement station, Rõka FAHM station established by the UT Institute of Ecology and Earth Sciences and ecosystem measurement station at Soontaga, which are also supported by the UT Institute of Physics Valgjärve micrometeorology, Tahkuse air monitoring and Tõravere meteorology measurement station. The stations and masts are used for the installation of measurement equipment, incl. different meteorological sensors and means of communication. These facilities are equipped with different measurement and communication systems. The measurement data can be used for different environmental data and meteorological analyses, incl. partially in real time via the Internet.

Experimental areas have been established in the Puh-tu-Laelatu complex for studying plant biodiversity, while Kõiguste field laboratory and an automatic station on the island of Keri contribute to marine studies. Inland water body studies are based on the work of the laboratories at Võrtsjärv Limnological Station. Most of these stations can be used for nature protection activities and as bases for environmental education. Experimental stations are

supported by a geomatics and geoinformatics laboratory, which develops methods for the collection, processing, analysis and visualisation of spatial data and provides support services for processing spatial data in applied planning.



Photo: Kaido Soosaar

Integrated Carbon Observation System

Acronym: **ICOS ERIC**

Website: www.icos-ri.eu

Estonia's membership status: pending



The Integrated Carbon Observation System is a pan-European research infrastructure that measures the dynamics of Earth's greenhouse gases. ICOS combines atmosphere, ecosystem and ocean greenhouse gas observations to provide reliable data on the balance and variation of the carbon cycle and other greenhouse gases for both research and public policy making. Currently, the ICOS network consists of more than 100 measurement stations providing high quality measurements on greenhouse gas fluxes and concentrations in over 12 European countries. Additionally, ICOS coordinates data provision via the ICOS Carbon Portal and ensures the quality control of data through the activity of central facilities.

Joining the ICOS network gives Estonia the opportunity to have a say in the launching of a pan-European experimental network for climate and environmental research and actively participate in the compiling of data collections that shape EU climate actions. This enables Estonia to have a more accurate overview of the impact of climate change mitigation measures at national and EU level, including the development of further strategies and operational plans. Based on this data, applied outputs in the field of plant and forest cultivation and water body use are generated. Estonia has the opportunity to participate in the process of compiling this database via, for example, smart climate-friendly forest management and LULUCF (Land Use, Land Use Change and Forestry) strategies, while also having a better control over substances under internationally agreed pollution control (LRTAP—The Convention on Long-Range Transboundary Air Pollution), improving air quality and ensuring sustainable development in bio-economy.



Photo: Steffen Noe

Analysis and Experimentation on Ecosystems

Acronym: **AnaEE**

Website: www.anaee.com

Estonia's membership status: pending



Analysis and Experimentation on Ecosystems is a pan-European infrastructure for experimental studies of managed and unmanaged terrestrial and aquatic ecosystems. It consists of a coordinated network of experimental platforms (laboratories and experimental stations) involving different ecosystems and climatic zones, the main task of which is to use experiments to study future scenarios related to climate change, agriculture and land use, i.e. to forecast the impact of environmental and human activity on the economy and nature. National platforms are coordinated and supported by pan-European centres: the Central Hub in Paris as well as technical, data management, modelling and application centres.

Participating in the AnaEE network will have a positive effect on the implementation plan for the development of the economic environment as well as strategies and development plans concerning adapting to climate change. AnaEE's activities are consistent with the Estonian environmental strategy's measures for the preservation of biodiversity and mitigating climate change. The positive impact manifests in issuing high-quality information that meets international requirements and standards, which can be used as an input for research, national and international reports and strategies. The infrastructure of experimental ecology contributes to the development and implementation of operational programmes in fields of national importance such as the development plans of forestry and the use of oil shale, helping to establish and achieve objectives related to environmental protection and the sustainable use of resources, incl. by supporting the growth area of smart specialisation and the more efficient use of resources in utilizing bioeconomic, incl. forest and ecosystem, resources.



Photo: Priit Kupper

Natural History Archives and Information Network

Acronym: NATARC

Lead institution: University of Tartu

Partner institutions: Tallinn University of Technology, Estonian University of Life Sciences, Tallinn University, Estonian Museum of Natural History, Environment Agency, Environmental Board

Contact person: Urmas Kõljalg, urmas.koljalg@ut.ee

Website: natarc.ut.ee

Natural History Archives and Information Network is an integrated infrastructure based on natural sciences and open data. The open data information system developed by NATARC covers all data types related to Estonian natural science collections.

Estonian research and development institutions' information systems and applications based on national botanical, geological, microbiological, mycological and zoological collections can be interrelated through meta-data, location, ecology, DNA sequences and other data. Following the principles of open data, the whole dataset is machine-readable, accessible and quotable. NATARC collections and information system can serve as a basis for interdisciplinary research, natural education applications and the assessment of the state of endangered species and ecosystems.

Distributed infrastructure services consisting of digital (central data management platform PlutoF that combines digital archives and portal eElurikkus) and physical (scientific collections and laboratories) provide excellent research opportunities for bio-sciences and geo-sciences

both in Estonia and globally. The NATARC information system has become one of the most commonly used global tools in its field and its functionality serves as a basis for excellence in research projects. NATARC grants researchers from Estonia and the rest of the world access to all of Estonia's biological and geological data, making it possible to conduct basic and applied research from taxonomy to metagenomics. The PlutoF open-data management platform has become one of the most widely-used services in the world, as it has users from more than 80 countries.

Participants of the NATARC network include all research and state institutions that manage Estonian natural science collections and are responsible for the development of digital archives: the University of Tartu, Tallinn University of Technology, the Estonian University of Life Sciences, Tallinn University, the Estonian Museum of Natural History, the Environment Agency and Environmental Board. NATARC provides biodiversity and geological archive and information system services to Estonian officials, entrepreneurs and the public. The open infrastructure allows both the public sector as well as private companies to access reliable environmental data.



Photo: Natural History Museum, University of Tartu

Distributed System of Scientific Collections

Acronym: DiSSCo

Website: dissco.eu

Estonia's membership status: pending



The Distributed System of Scientific Collections is a pan-European consortium of research and development institutions that manage natural scientific collections, the purpose of which is to digitally connect European natural scientific collections (herbariums, entomological collections, biobanks, DNA collections, etc.) to create conditions for their joint and cross-use in frontier science and innovation. The consortium includes 115 research and development institutions from 21 European countries, who manage more than 1.5 billion specimens in total—this constitutes 55% of the world's natural scientific collections and 80% of the world's documented biodiversity.

Membership in DiSSCo allows Estonia to become one of Europe's competence and innovation centres for developing data management and analysis services. The central element in this is the PlutoF data management system that offers collection-based high-quality e-services developed within the framework of NATARC. Participation in the work of the DiSSCo network enables Estonia to offer the competitive advantage and competence acquired in implementing NATARC to develop global IT solutions. One of Estonia's main goals is to make PlutoF part of the European Open Science Cloud, which would increase the visibility and availability of the Estonian digital infrastructure for open data.

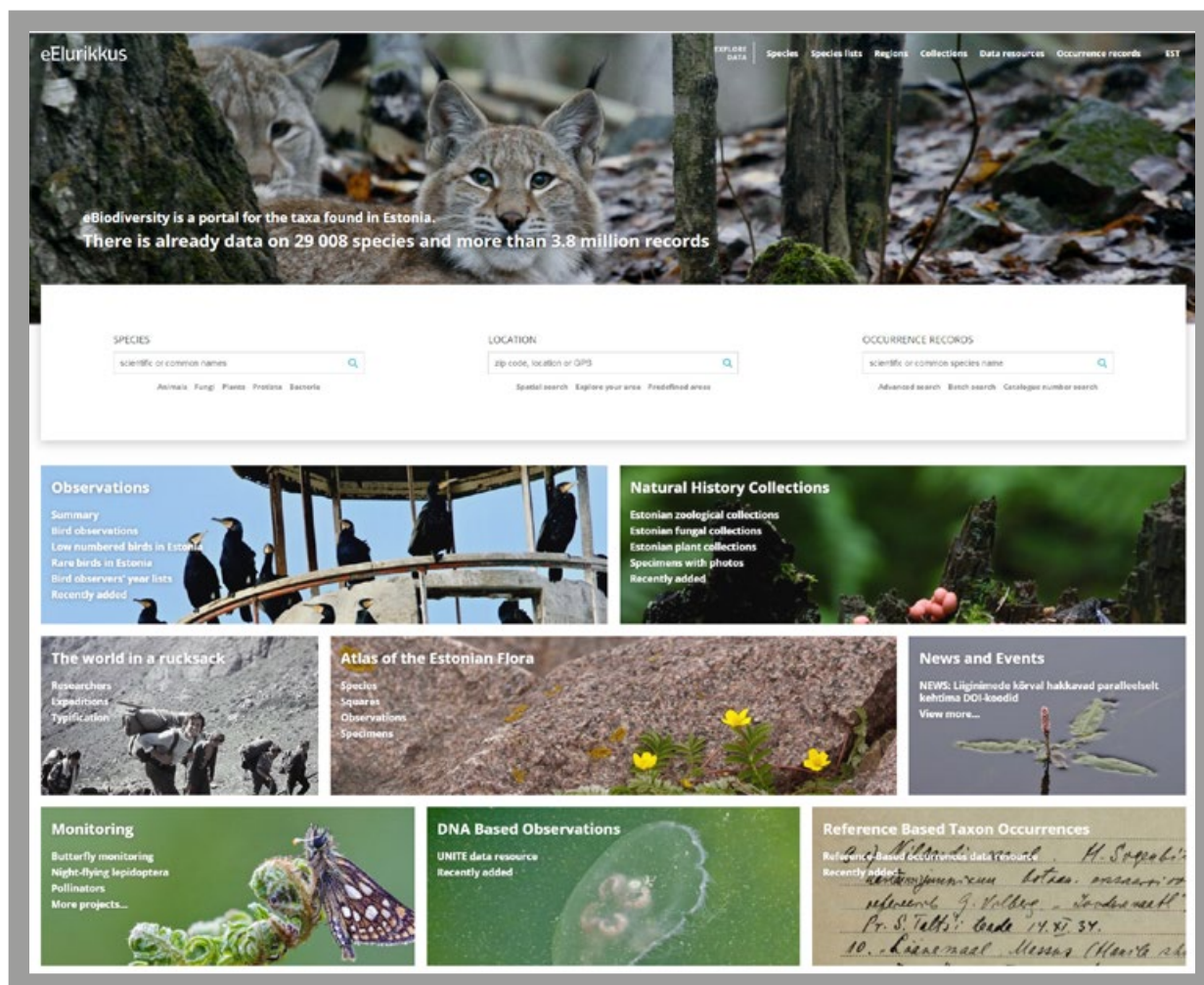


Image: Portal eElurikkus



Physics and Engineering



Estonian Center of Analytical Chemistry

Acronym: ECAC

Lead institution: **University of Tartu**

Partner institutions: **Tallinn University of Technology, Estonian Environmental Research Centre, National Institute of Chemical Physics and Biophysics**

Contact person: **Ivo Leito**, ivo.leito@ut.ee

Website: akki.ut.ee

The Estonian Center of Analytical Chemistry combines the high-quality infrastructure of four partners: the University of Tartu, Tallinn University of Technology, the Estonian Environmental Research Centre and National Institute of Chemical Physics and Biophysics. The organisation includes three distributed core laboratories that bring together the equipment and know-how of ECAC partners. The core laboratories develop analytical methods, analyse samples and organise professional training.

The bio-medicinal, food and environment core laboratory combines mass spectrometry, chromatography and electrophoresis systems for a variety of analyses. Examples include: analysis of bio(bodily)fluids (pharmaceuticals, metabolites, biomarkers, micro-, macro- and toxic elements etc.); environmental samples (pesticides, mycotoxins, pharmaceutical residues, etc.); and food and plant materials (flavonoids, anthocyanidin, other polyphenolic compounds etc.).

The materials, structure and microanalysis core laboratory combines spectroscopy instruments with wide-range properties covering all practical electromagnetic radiation wavelengths. Infrared, terahertz, nuclear magnetic resonance spectroscopy and x-ray instruments as well as microscopy and plasma-based methods are used for the analysis of solid and liquid organic or inorganic materials and samples. Molecular and elemental composition of compounds can be measured using highly sensitive instruments (ppt level) in a wide range of sample sizes (from

industrial test objects to nanoscale objects). Examples include: analysis of the composition of surface materials, plastics and films, materials and mixtures with complex multiple component compositions; the qualitative and quantitative analysis of crystalline solids; analysis of heat capacity, phase transitions and magnetic properties.

The industrial, legal and applied core laboratory combines physico-chemical methods that are used to develop analytical methods in industry, knowledge-based innovation and development. It provides services (incl. method development and sample analysis) and focuses on the capacity to solve problems and consult in nonstandard situations.

ECAC has a wide range of potential beneficiaries. These include all fields of natural science and technology from basic and applied research to monitoring the quality of the output of industrial processes, but also studies of industrial production and different types of materials, which call for methods of analytical chemistry. The purpose of ECAC is to optimise the use of high-quality chemical analysis resources—which are limited in Estonia—and make them widely available. To this end, ECAC will create an equipment cross-use network platform. ECAC is also a centre of analytical chemistry education and knowledge transfer, offering training courses on different levels and in different forms (face-to-face and web-based). ECAC represents Estonia in Europe's leading analytical chemistry organisation Eurachem.

Marine Technology and Hydrodynamics Research Infrastructure

Acronym: SCC

Lead institution: Tallinn University of Technology

Partner institutions: Baltic Workboats AS, Association of Estonian Marine Industries

Contact person: Anni Hartikainen, anni.hartikainen@taltech.ee

Website: www.scc.ee

The Marine Technology and Hydrodynamics applied research infrastructure advances the Estonian marine industry. The core of the infrastructure is the Small Craft Competence Centre in Kuressaare, which is home to the only ship model towing tank (test basin) in the Baltic States. At SCC, researchers combine model and materials testing with computational methods and virtual technologies.

Marine technology and shipbuilding are based on applied sciences such as ship theory, product development and production engineering, ship systems, etc., which are in turn founded on basic sciences such as physics, mechanics, materials science. The marine industry is a conservative field regulated by international conventions, standards and classification rules. New materials, design solutions and technologies are created through extensive experimental research and numeric simulations.

A towing tank with a sea-mimicking wave generator is at the heart of the applied research at SCC. The towing tank is used for testing technological solutions and validating calculation methods. Modern computational methods push the boundaries of experimental research and allow

design solutions to be assessed for optimum performance before experimental testing.

The SCC has facilities for towing tank and open-water model testing, numeric simulations, assessing materials and technologies in marine climate conditions and under wave loads. In the near future, SCC laboratories will be supplemented by the newest methods, including the development of an open-water testing site for autonomous ship models as well as naval design and testing opportunities that involve virtual and augmented reality technologies.

SCC's partners are Tallinn University of Technology, Baltic Workboats AS, Saaremaa Rural Municipality and the Association of Estonian Marine Industries. The largest producer of workboats in the region, Baltic Workboats AS, offers the possibility to establish a virtual naval design innovation and training centre at its shipyard. From Tallinn University of Technology, Naval Architecture and Hydrodynamics Research Group, Mechanics of Fluids and Structures Research Group, Centre for Intelligent Systems, Mechatronics and Autonomous Systems Centre and Wave Engineering Research Group are actively involved in SCC's activities.



Photo: Valmar Voolaid

Center of Nanomaterials Technologies and Research

Acronym: NAMUR+

Lead institution: University of Tartu

Partner institutions: Tallinn University of Technology, National Institute of Chemical Physics and Biophysics

Contact person: Vambola Kisand, vambola.kisand@ut.ee

Website: sisu.ut.ee/namurplus

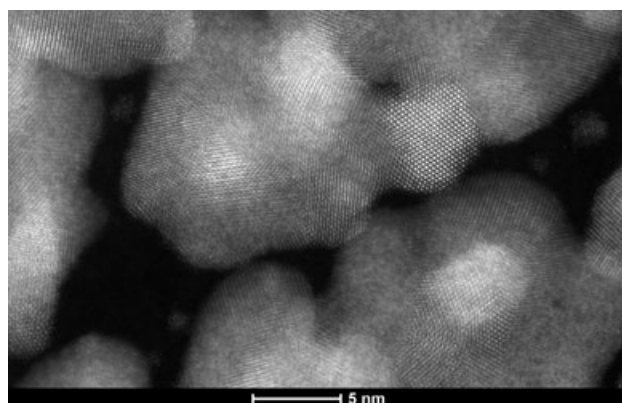
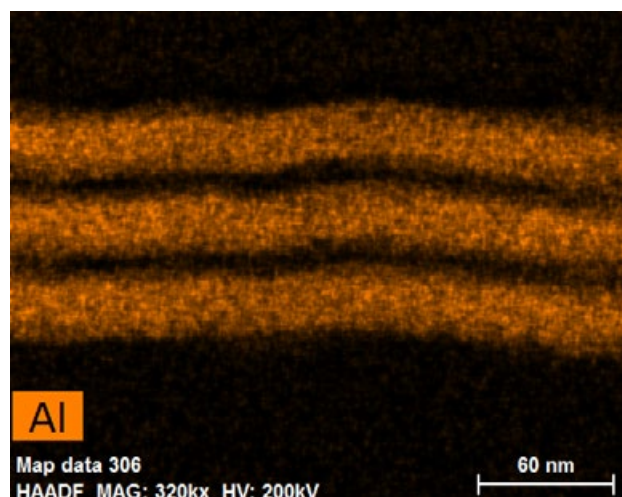
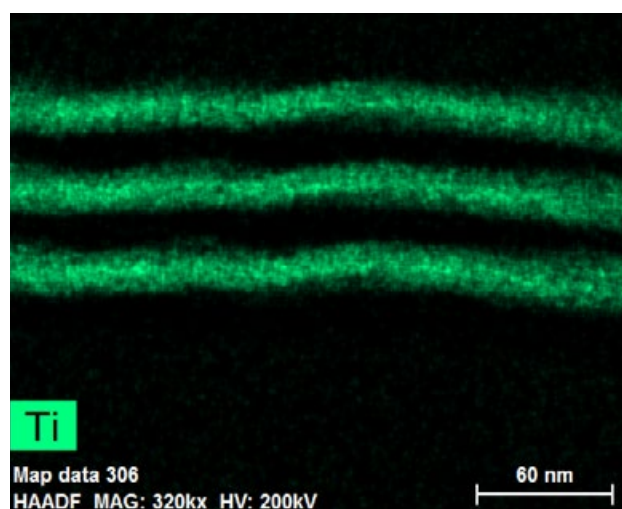
The main goal of the Center of Nanomaterials Technologies and Research is to develop a cutting-edge infrastructure for manufacturing, studying and implementing nanomaterials and developing it into an attractive multifunctional centre providing R&D services in nanotechnology and nano-safety, using the high-level research capability of its partners.

NAMUR+ is based on the expertise of research teams of the University of Tartu's Institute of Chemistry, Institute of Physics, and Tallinn University of Technology as well as the Institute of Chemical Physics and Biophysics in the fields of materials science, high-efficiency energetics and nano-safety. The first part of the infrastructure was established in the period 2012–2015, when an analytical ultra-high resolution (scanning) transmission electron microscope (aHR-(S)TEM), a time of flight secondary ion mass spectrometer (FIB-TOF-SIMS) and a high-resolution scanning electron microscope (HR-SEM) complex were acquired. The second part of the infrastructure is to be completed in the period 2017–2021, which involves the procurement of an atomic layer deposition (ALD) reactor suitable for the production of solar cells, a C-60 ion source for FIB-TOF-SIMS analysis, micro-/nano-manipulators allowing electrical measurements and mechanical manipulations in HR-SEM and a micromechanical testing device. Support infrastructures are being developed for nano-safety studies, photo- and electron lithography, which involves the acquisition and sharing of the relevant competence in Estonia.

The research infrastructure enables to provide world-class services in nanotechnology and characterization of materials, incl. studies on the structure and composition of nanomaterials using the aHR-(S)TEM method, FIB-TOF-SIMS measurements for the composition studies of (inorganic) materials, HR-SEM studies of materials and the measurement of the mechanical properties of nanomaterials. Development of services related to ALD prepared materials for solar energetics, FIB-TOF-SIMS studies of organic materials, testing the biological effects of nanomaterials on the interactions of cells and organisms and their safe design as well as photo- and electron lithography is underway.

Members of the consortium and researchers from the Estonian University of Life Sciences have conducted research within the NAMUR+ infrastructure. Various research projects have supported the activities of several top-level research centres and helped to fulfil tasks related to institutional and personal research topics.

All of NAMUR+ devices have been used to offer services to Estonian companies (Silmet AS, Skeleton Technologies OÜ, Enics Eesti AS, Crystalsol OÜ, etc.) but also Finnish, Latvian, Bulgarian and German enterprises. NAMUR+ is used by more than 20 institutions in total.



Images: Mihkel Rähn

Smart Industry Centre

Acronym: SmartIC

Lead institution: Tallinn University of Technology

Partner institutions: Estonian University of Life Sciences, University of Tartu

Contact person: Tauno Otto, tauno.otto@taltech.ee

Website: smartic.ee

The Smart Industry Centre was established in 2017 with the purpose of bringing together the distributed infrastructures of research and development related to smart production in Tallinn University of Technology (TalTech) and the Estonian University of Life Sciences in the fields of mechanics, mechanical engineering, automation, mechatronics, materials science and engineering and ICT. It is a so-called distributed unit, designed to considerably improve research in the field of smart production and the cross-use of infrastructures in both Estonia (among universities and cooperation partners) and on an international scale (research and development cooperation projects, applied research with international companies, e.g. in aviation, automotive industry, shipping industry, etc.) via cooperation, marketing and jointly defined services, using the principles of reverse engineering and contemporary ICT tools such as virtual reality and big data processing. The core infrastructure is comprised of the laboratories of Taltech and the Estonian University of Life Sciences: Flexible Manufacturing System and Robotics Demo-centre, the Laboratory of Mechanical Testing and Metrology, ProtoLab OÜ, CT Laboratory, Measurement Laboratory, Industrial Virtual Reality and Augmented Reality Laboratory (IVAR), Self-driving Vehicles and Autonomous Systems Laboratory (ISEAUTO) and Acoustic Testing Laboratory.

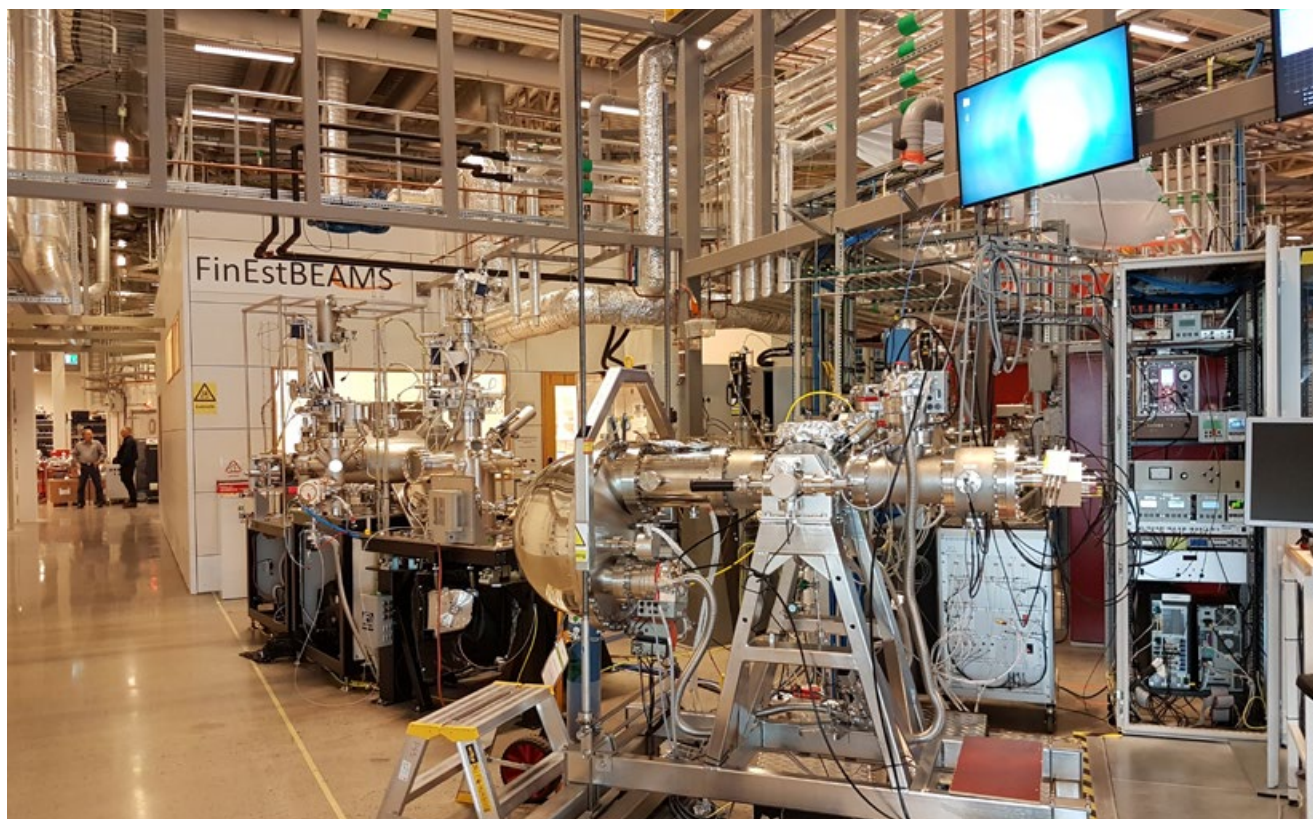
New laboratories support research related to quality control, focusing mainly on the additive manufacturing technology in the framework of SmartIC. 3D printing and XCT-combined research are of interest to the manufacturing sector, cooperation with whom allows putting new applied research into practice. Such a technological capability of metal/composite 3D printing followed by quality control by computer tomography is currently unique in the Baltic and Nordic region. It offers a wide range of

applications depending on the processing of different materials (metal, plastics, organic and inorganic materials) and the size and complexity of the object. The 3D printing system based on the Selective Laser Melting Machine SLM 280 2.0 purchased by Protolab provides a 280 x 280 x 365 mm³ build envelope and involves patented multi-beam technology. The high-resolution 3D scanner YXLON FF35 CT at the Estonian University of Life Sciences' Computer Tomography Laboratory has a dual tube system—225kV and 190 kV—, which ensures improved technological capability. In the course of development, the distributed infrastructure is expanded by smart workplace technologies to virtualise the connected laboratories by VR/AR means and allow the remote operation of devices.

In 2018, SmartIC was used to complete more than 100 commissions and R&D projects in the laboratories of the Estonian University of Life Sciences and TalTech. The main industrial partners in the field of 3D scanning, quality control, prototyping and product printing are EAS Batteries GmbH, International Aluminium Casting AS, Milrem AS, ABB AS, Cleveron AS, Chemi-Pharm AS, Pipelife AS, Ida-Tallinna Keskhaigla AS, Balteco AS, Sporrong Eesti OÜ, Skeleton Technologies OÜ, Plastone OÜ and Roman Tavast OÜ. In terms of research projects, the infrastructure is involved in developing 3D printed electrical machines, for instance. The largest cooperation project was related to the Maarjamäe Memorial to the victims of Communism in Estonia, the design process of which involved scanning a bumblebee borrowed from the Estonian Museum of Natural History with a tomograph, which was then digitally modified and optimised to produce clusters of different size and appearance that would be as light as possible, but damage-resistant at the same time. Over 20,000 digitally individualised steel bees were 3D printed using stainless powder material.



Photo: Kristjan Kruuser



Estonian-Finnish beamline at MAX-IV Synchrotron Radiation Source

Acronym: FinEstBeAMS

Lead institution: University of Tartu

Contact person: Marco Kirm, marco.kirm@ut.ee

Websites: www.finestbeams.eu, www.maxiv.lu.se/accelerators-beamlines/beamlines/finestbeams

The Estonian-Finnish beamline FinEstBeAMS is located at the MAX-IV laboratory's 1.5 GeV synchrotron in Lund, Sweden and is designed for materials and atmospheric physics studies. The infrastructure is equipped with three end stations for gas-phase experiments, ultra-high vacuum studies of surfaces and interfaces and photoluminescence in solids under synchrotron radiation excitation of 4.4–1300 eV. The beamline covers a wide spectral range from ultraviolet to soft X-rays, which is well suited for the spectroscopic investigation of various materials. Based on this, research methods can be divided into three classes: 1) gas phase methodologies 2) luminescence spectroscopy of materials, and 3) studies of bulk solids and their surfaces. FinEstBeAMS allows a large number of researchers and companies to conduct studies on the electronic structure and energy relaxation process of free molecules, atmospheric and nanoparticles, clusters, liquids, solids and their surfaces for obtaining basic knowledge and applied purposes. The beamline was built thanks to the close cooperation of scientists from the University of Tartu and three Finnish universities (Turku, Oulu and Tampere). It is the first international investment into the infrastructure of the MAX IV Lab. The commissioning of FinEstBeAMS was completed in

2018. To date, this has been followed by three competitive calls for beamtime.

The MAX IV Lab has constructed two storage rings operating with electron energies of 1.5 GeV (providing ultra-soft X-rays) and 3 GeV (hard X-rays), respectively, and the synchrotrons can accommodate up to 30 beamlines. Eight of these are already in operation on a regular basis and an additional eight have secured required funding. Thanks to investments, each partner can use an agreed amount of beamtime at any beamline in the MAX-IV Lab. In addition to experiments on the unique FinEstBeAMS spectroscopy beamline (€3 m investment by Estonia) in the XUV–VUV area, Estonian researchers and technology developers can conduct studies at a beamline in the volume agreed on with the MAX-IV Lab (depending on the size of the investment) irrespective of their field of research and sectorial (public or private) origin. The most important result of the project is that Estonian scientists, students and technology experts are part of a community that can use the excellent research opportunities of the MAX-IV Lab, which—together with European Spallation Source, also based in Lund—is part of the biggest research centre in Northern Europe.



European Space Agency

Acronym: **ESA**

Estonian coordinator: **Anu Reinart**, anu.reinart@ut.ee

Website: www.esa.int/ESA

Estonia's membership status: full member (2015)

The European Space Agency is an intergovernmental organization established in 1975, which coordinates the peaceful exploration and exploitation of space in Europe. ESA is active in many fields: space science, Earth observation, satellite navigation, telecommunications, manned spaceflight, launchers, educational programs etc. In 2018, the budget of ESA was 5.6 billion euros, which was distributed between various programmes. The space science programme (518.2 million euros) and the general budget (237.2 million euros) belong to the compulsory programme. ESA infrastructure is fully accessible to member states only. Member states can participate in optional programmes depending on their goals and abilities. ESA currently has 22 member states (including Estonia) and has entered into cooperation and association agreements with nine other countries. ESA is constantly evolving—new space missions are planned and prepared according to the interests of the countries participating in the programs, their opportunities and mutual agreements.

Estonia became a full member of ESA in 2015. Estonia's relations with ESA are coordinated by Enterprise Estonia (EAS). Membership in ESA opens up excellent development prospects for our high-tech companies and all R&D institutions. As a member state, Estonia has its representatives in the ESA Council and committees, where important decisions are made on the development and future of European space research and technology. The principle of geographical return ensures the growth of member states' research-intensive production and facilitates their competitive power. Estonia's ESA membership fee is approximately 2.5 million euros per year. Estonia is currently participating

in two optional programmes: Earth Observation Envelope Programme (EOEP) and General Support Technology Programme (GSTP). Extending participation to include the ARTES telecommunication programme and the PRODEX programme for developing cutting-edge instrumentation and scientific missions is under discussion. In 2017, Tartu Science Park led the initiative to establish the Estonian ESA Business Incubator Centre in partnership with local government units, the University of Tartu and TalTech, which has now launched six spin-off companies.

Estonian priorities in developing space science and technology are in compliance with the framework of ESA's long-term strategy *Cosmic Vision 2035*. Based on the competence of R&D institutions and companies as well as the needs of knowledge-based economy, Estonia is planning to establish its own space programme, combining the interests of the public and private sector. Today's Estonia has teams with world-class skills necessary to participate in space missions with their own technology. With the help of additional investments, there is a need to develop networks of terrestrial support stations for space missions to perform astronomical measurements and data analysis (e.g. ESA's large-scale missions ARIEL, ATHENA and F-mission), improve the measurement accuracy of data from remote monitoring satellites (hyperspectral sensors) and test algorithms of new autonomous operation systems for both space and terrestrial applications. ESA has also launched a call for ideas for the preparation of its next strategy, *Voyage 2050*, which is the first time Estonia can systematically contribute to the shaping of the future of technology and research with its ideas.

European Spallation Source



Acronym: European Spallation Source ERIC

Estonian coordinator: Enn Lust, enn.lust@ut.ee

Websites: europeanspallationsource.se, esss.ee

Estonia's membership status: founding member (2015)

The European Spallation Source is an international cooperation project between 17 European countries, the aim of which is to build and maintain a research infrastructure object of the next generation, which is mainly designed for medical, biochemistry and materials studies with the use of neutrons. ESS is to be built in Lund, Sweden, and its computing centre will operate in Copenhagen, Denmark. It is estimated that the research infrastructure will be completed by 2025.

ESS will be a unique neutron source in the world, distinguished by its high brightness. The first 15 instruments will be the best in the world in terms of their neutron beam intensity and resolution and will enable to perform unique experiments in biochemistry, chemistry, physics, geology and many other fields. Neutron scattering methods are very informative when it comes to studying hydrogen bonds, other hydrogen structures and the dynamics thereof. The completion of ESS will be a giant leap in the field of biomedical, pharmaceutical, biochemical and hydrogen technology in-operando research and development. As neutron scattering methods are nearly non-destructive, the dynamics of many processes in biochemistry, medicine and technology can be monitored continuously in the course of

long periods of time (days, weeks, etc.). Neutron scattering can also be used to study the properties of fully-assembled systems from operating fuel cells, electrolyzers, biochemical reactors and hydrogen storage systems to details of aeroplane wings and frames under strain.

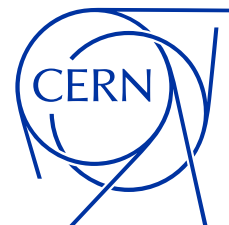
In the course of the project, researchers will be trained to create a sustainable neutron scattering user community in Estonia. In cooperation with Estonian businesses, suitable methods for the analysis of high-tech materials and devices in-operando will be devised to produce new competitive products. The training of specialists capable of using neutron scattering methods and related infrastructure is vital to assure the large-scale impact of ESS on the achievements of research institutions and to support the growth of smart specialisation areas.

Thanks to ESS, Estonian researchers and engineers can access a unique research infrastructure that can be used to perform innovative, high-impact work in different fields of research. This increases the international visibility of Estonian researchers and Estonia will become a more attractive destination for top scientists and cooperation partners working in research and knowledge-based entrepreneurship.



Image: European Spallation Source ERIC

European Organization for Nuclear Research



Acronym: **CERN**

Estonian coordinator: **Mario Kadastik**, mario.kadastik@kbfi.ee

Website: cern.ch

Estonia's membership status: associated membership application submitted in 2018

The European Organization for Nuclear Research is an international research and technology centre situated on the Franco-Swiss border near Geneva, the primary research field of which is experimental particle physics. CERN currently has 23 member states and seven associate member states. It hosts the world's biggest particle accelerator (LHC – Large Hadron Collider), which is linked to four large particle physics detectors. CERN also conducts R&D in several other fields, for instance, in 2019, the organisation is studying antimatter and the Higgs boson discovered in CERN, develops new materials and accelerators, IT and distributed computing, conducts environmental research and deals with questions of health technology. CERN offers highly varied cooperation opportunities: members can mainly participate in experiments in CERN research facilities, where international research and development cooperation is conducted, but also use the organisation's high-quality IT infrastructure and computing power.

Estonia has collaborated with CERN for over 20 years, taking part in accelerator experiments and performing data analysis. In the last five years, Estonia has also participated in a smaller capacity in developing new accelerator experiments and testing technological solutions for Compact Muon Solenoid (CMS), Compact Linear Collider (CLIC) and Crystal Clear Collaboration (CCC) accelerator experiments. CERN is also an education hub that organises annual

summer courses for students, which offer scholars from all over the world, incl. Estonia, important knowledge and allow them to meet top specialists in their fields. More than 100 Estonian students have participated in this programme. CERN also trains secondary school physics teachers, helping to introduce the achievements of top-level research in school lessons in an innovative way. Estonian teachers have participated in this programme for many years and it has motivated them to encourage students to think about the achievements of top-level research and technology and steer their future career choices towards science and technology.

Before becoming a full member, associate membership status provides Estonian enterprises and R&D institutions the opportunity to engage in immediate industrial collaboration, participate in CERN procurements and gain access to the organisation's vast new technology portfolio as well as educational programmes ranging from engineer training to full PhD projects in many fields. CERN's technology transfer programmes to member states are not limited to particle physics. Universities' and companies' cooperation with CERN results in new applications for methodologies and equipment developed at CERN in the fields of IT, security, materials science, environmental and health technology, thus contributing to technology transfer and social development on multiple levels.

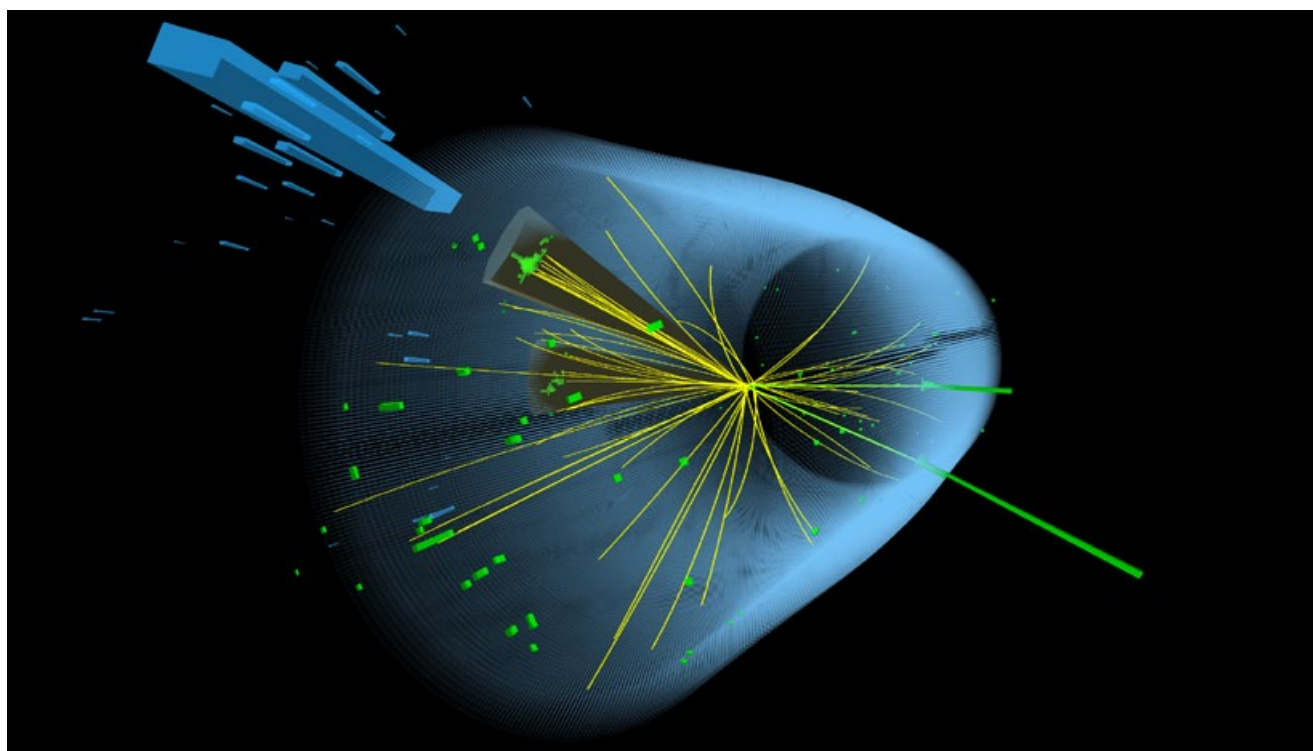


Image: European Organization for Nuclear Research (CERN)



Health and Food Science

Estonian Center for Genomics

Acronym: ECG

Lead institution: **University of Tartu**

Contact person: **Andres Metspalu**, andres.metspalu@ut.ee

Website: genoomikakeskus.ut.ee

The objective of the Estonian Center for Genomics is to meet the needs of Estonian R&D in terms of genome analysis, including competitive participation in international collaborations and applications in healthcare and entrepreneurship.

The infrastructure consists of the database of the Estonian Genome Center at the University of Tartu (EGCUT) that contains tissue samples, OMICS data and medical information from 152,000 individuals, and a temporal reference database of genomic data created as an additional module to extend the reference database already established by the Estonian Biocentre. The world-class equipment for genomic analysis acquired through various measures enables to carry out research projects quickly and efficiently and offer services to scientific research institutions and laboratories, hospitals and businesses both in Estonia and abroad. In Estonia, one of the key goals of the infrastructure is to expand diagnostic and treatment possibilities by promoting and implementing personal medicine in Estonia, thereby contributing to improving public health.

One of the key goals of the infrastructure has now been accomplished: using the new high-density genotyping chip, DNA analysis of 52,000 gene donors has been performed. With additional funding from the Estonian Ministry of Social Affairs, the volume of the Estonian Genome Center's database was increased by 100,000 new gene donors. In accordance with the Human Genes Research Act, a

project that involves giving personal genetic feedback to the gene donors has been initiated and over 2,000 individuals have already used this opportunity. The state has initiated additional actions with regard to personal medicine (development of IT solutions, etc.). This is a prime example of knowledge transfer from research to practical medicine, which has become possible due to the continuous data quality improvement in the Estonian Genome Center.

Genomic data from 52,000 gene donors, imputed with upgraded reference, are open to further scientific research. In the coming years, the quantity of genomic data analysed by EGCUT and issued for use in scientific cooperation projects will increase remarkably. The qualitative upgrading of the Estonian Genome Center's database with a new module—microbiota samples from the gut and other locations—will continue. Initially, gut microbe samples will be collected from approximately 2,000 gene donors.

The temporal reference database for genomic data that is being established within the scope of the infrastructure is open to the whole global scientific community for population genetics research. It will provide substantial output for identifying hidden genealogical information, making it possible to increase the statistical power of genetic association studies. With the completion of a special laboratory for old DNA, it is now possible to isolate and purify DNA from archaeological material on site.



Photo: Karl Erik Piirimees

Biobanking and Biomolecular Resources Research Infrastructure



Acronym: **BBMRI ERIC**

Website: www.bbmri-eric.eu

Estonia's membership status: founding member (2013)

BBMRI ERIC is a unified pan-European research infrastructure of biobanks and biomolecular resources, the primary objective of which is to harmonise biobanking in Europe, establish and reinforce an international cooperation network and promote the efficient utilisation of the research infrastructure. Above all, BBMRI ERIC ensures secure access to clinical databases, thus facilitating the organisation of research and promoting international cooperation in biotechnology, medicine as well as the pharmaceutical industry. In Estonia, the national institution that carries out BBMRI ERIC's activities is the Estonian Genome Center at the University of Tartu.

The centre contributes to the work of the network in four sectors:

- ELSI (ethical, legal and societal issues)—mapping of ethical, legal and social aspects of European biobanks
- IT and new technologies—development of information technology solutions for biobanks; one of the goals is to create a pan-European catalogue of biobanks and the samples retained therein
- Quality management systems—the goal is to map and update existing quality system standards
- Training activities sector—the aim is to facilitate cooperation between biobanks, develop new curricula and training for starting biobanks.

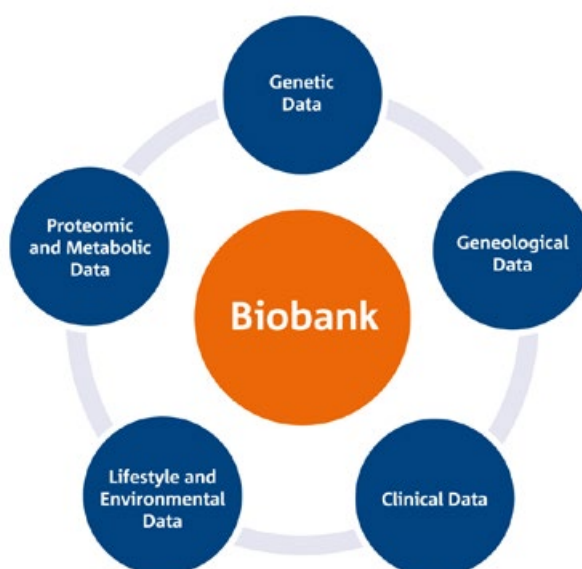


Image: BBMRI ERIC

Estonian node of European Life-sciences Infrastructure for Biological Information

Acronym: **ELIXIR Estonia**

Lead institution: **University of Tartu**

Partner institutions: **Tallinn University of Technology, National Institute of Chemical Physics and Biophysics, National Institute for Health Development**

Contact person: **Jaak Vilo, jaak.vilo@ut.ee**

Website: **elixir.ut.ee**

Today's research produces great amounts of data and some fields of research are largely based on data-based methods, thus requiring interdisciplinary IT solutions. Life science fields from molecular biology to agriculture and health science are connected on a molecular level by measurable research objects, be they humans, plants or bacteria. Everyday research generates very different data, the sustainable valorisation of which requires cross-border contributions. The long-term management and retention of data cannot be sustainable on a national level—it must be based on data type specificities; data must be standardised and stored in sectoral databases regardless of their location. In order to offer better knowledge and create globally competitive services, Estonia participates in the international bioinformatics research infrastructure ELIXIR.

Instead of gathering knowledge and tools in one place, the purpose of ELIXIR's distributed structure is to call upon members' strengths. ELIXIR combines member states' services, tools, training opportunities and databases into a large unified research infrastructure for bioinformatics. Such a unified global research infrastructure helps researchers to perform data analysis and interpret the results. For end users, this integrated research infrastruc-

ture, which follows shared practices, provides easier access to biological information tools.

ELIXIR Estonia's members are the University of Tartu, Tallinn University of Technology, the National Institute of Chemical Physics and Biophysics and the National Institute for Health Development, but it is also beneficial to other research institutions and companies. ELIXIR Estonia mainly focuses on the development and operation of world-class services and tools, improving the data analysis capability of professional researchers by offering training and management of metagenomic and population data. In cooperation with the Estonian Scientific Computing Infrastructure (ETAIS), ELIXIR Estonia ensures the constant availability of web services to both Estonian researchers and a very large international user community. The most widely-used tools of ELIXIR Estonia are Primer3 and g:Profiler, which facilitate the daily work of thousands of people. g:Profiler is also featured among the interoperable tools recommended by ELIXIR. With the help of Estonian and international ELIXIR members, ELIXIR Estonia trains both Estonian and foreign researchers and has so far offered courses on data analysis, basic programming, data management and the use of ELIXIR tools.



Image:
ELIXIR Estonia



European Life-sciences Infrastructure for Biological information

Acronym: **ELIXIR**

Website: www.elixir-europe.org

Estonia's membership status: founding member (2013)

ELIXIR is the European Life-sciences infrastructure for Biological Information that unites 23 countries and is used by hundreds of thousands of researchers in the fields of molecular biology, environmental sciences, agriculture and medicine. All of these researchers create very different data, which need to be analysed with world-class software services and managed by sustainable databases. The purpose of the ELIXIR research infrastructure is to bring together data, tool, computer resource and training service providers in the field of life sciences under a unified infrastructure, the members of which have a joint liability for submitting and managing biological data. Instead of collecting knowledge and tools in one place, the distributed structure of ELIXIR aims at relying on members' strengths.

Estonia has actively participated in the following activities: development of the ELIXIR communication platform, i.e. the virtual café; automatic annotation of data required to create bio.tools, a database that describes the tools of bio-informatics; development of an automatic workflow based on descriptions of bioinformatics tools in cooperation with ELIXIR France; development of annotation software for ELIXIR training materials workflow in cooperation

with ELIXIR UK; development of the best practices of software development and analysis of the competence requirements set for software developers. Thanks to membership in the ELIXIR network, Estonia has had the opportunity to participate in the development of ELIXIR's central registers such as TeSS and bio.tools, contribute to the development of best practices in software development and learn about the management of sensitive data from other ELIXIR member states. Additionally, Estonian training staff has received training on teaching adults and gained international experience in implementing knowledge.

Active participation in the ELIXIR training programme has given the opportunity to promote Estonian software services in other member states. Thanks to ELIXIR membership, Estonian researchers who are active in life sciences have been included in the shared information space and can have a say in the development of the newest practices and standards. Awareness of public tools and data analysis practices has improved thanks to varied local training events and the extensive cooperation network helps to find research and infrastructure groups facing similar challenges from all over Europe.

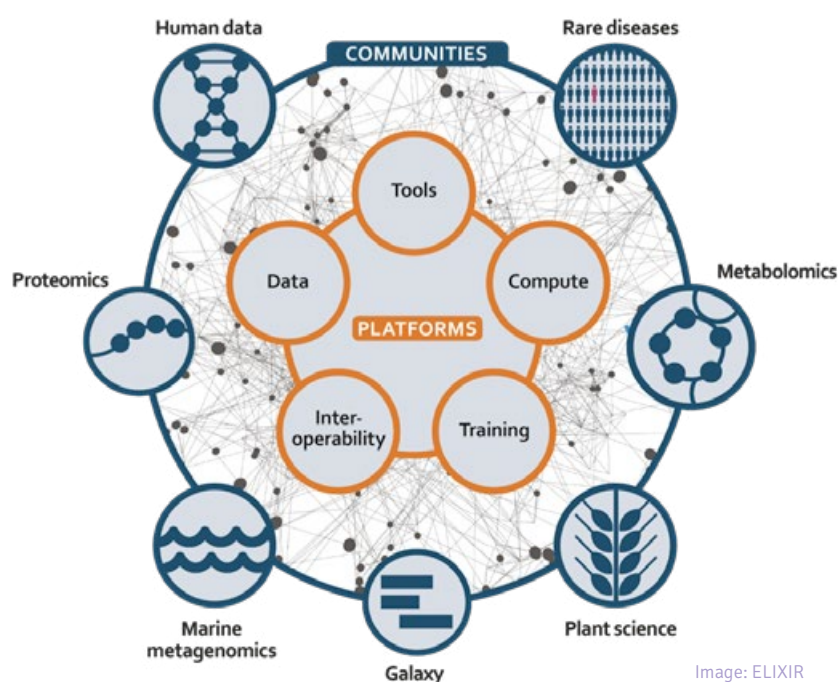


Image: ELIXIR

National Center for Translational and Clinical Research

Acronym: **CTM**

Lead institution: **University of Tartu**

Partner institutions: **Estonian University of Life Sciences, Tartu University Hospital**

Contact person: **Katrin Kaarna, katrin.kaarna@ut.ee**

Website: **www.ctm.ee**

The National Center for Translational and Clinical Research was established in 2010 in cooperation with the University of Tartu, the Estonian University of Life Sciences and Tartu University Hospital. Its mission is to ensure high-quality health research in Estonia. To this end, a contemporary translational medicine centre was founded in Tartu, followed by the development of a centre for clinical research. The research infrastructure improves the international competitiveness of health research in Estonia and on the international scale, facilitates networking and speeds up putting research results into practice. The CTM ensures the availability of technology required for preclinical and clinical research and user support for doctors, researchers, doctoral students, resident doctors and other research team members.

In order to support preclinical studies, CTM has access to contemporary biological material visualisation technologies. The Tartu facility is one of the most cutting-edge

centres in Central and Eastern Europe and deals with the development of different animal models, mainly focussing on studying psychiatric, neurodegenerative and immunoinflammatory diseases and tumours.

The Center for Clinical Research organises the project management of clinical studies and training events related to conducting research. The centre provides advice on applying for permits from the ethics committee and the State Agency of Medicines and in questions pertaining to clinical or translational research (report design, randomisation, various forms and aids) and help with the management of bioresources, biobanks and collections of biological materials. It provides assistance with writing grant applications and finding funding for existing research projects. In order to give a thorough overview of the possibilities of funding research, a research grant database has also been created.



Photo: Johan-Paul Hion

Plant Biology Infrastructure

Acronym: **TAIM**

Lead institution: **University of Tartu**

Partner institutions: **Estonian University of Life Sciences, Tallinn University of Technology, Estonian Crop Research Institute**

Contact person: **Hannes Kollist, hannes.kollist@ut.ee**

Website: **www.taimebiologia.ee**

The Plant Biology infrastructure is a developing infrastructure that facilitates the implementation of research-based smart practices for the efficient use of plants, expanding the application fields of plants and developing precise agriculture solutions in Estonia. The research infrastructure includes energy-efficient plant growth facilities, test fields, related equipment and sensor systems for monitoring plants in their growing environment.

Ensuring food safety and developing bioeconomy are some of the main objectives of the European Union, the achievement of which requires the expertise of plant biologists. Many fields of life are increasingly interested in using plant materials, for instance, using plants for the efficient production of therapeutic proteins or growing plants in urban environments. Development of plant genetic methods and the collection of species-specific genetic data in databases have been conducive to this development. In order to realise this dataset, investments into the development of phenotyping technologies have sharply increased in the European Union, because they allow correlating gene sequences and significant characteristics of plants, i.e. their phenotypes, and obtaining information for plant breeding.

TAIM develops infrastructure solutions that foster experimental work with agricultural species, which Estonian universities currently lack. This includes investments into innovative monitoring and phenotyping technologies, which can be used to monitor plants as they grow in a laboratory, greenhouse or field. These technologies—different gas exchange systems, field sensors, monitoring masts and drones—allow to monitor the condition of plants or fields and collect data in real time. The planned developments combine the basic knowledge obtained from universities' laboratories with practical plant breeding experience and large-scale crop tests of the Estonian Crop Research Institute and ensure knowledge transfer to the bioeconomy sector.

The Plant Biology Infrastructure enables to determine the physiological, biochemical, morphological and disease resistance-related characteristics of agricultural species and communities in laboratories, greenhouses and fields; focus on phenotyping services, in which the research infrastructure has high competence: plant gas exchange (water use and photosynthesis), emission of volatile substances, measurement of different stress responses and detection of pathogens with the help of imaging and genetic markers; develop 'from lab to field' devices and sensor systems that can be used to monitor the functioning of plants in field conditions in real time and optimise plant cultivation practices; and test the suitability of new crops and plant varieties to Estonian conditions.



Photo: Kaspar Koolmeister



Photo: Mati Koppel



European Molecular Biology Laboratory

Acronym: **EMBL**

Estonian coordinator: **Toivo Maimets**, toivo.maimets@ut.ee

Website: www.embl.org

Estonia's membership status: Prospect Member since June 2019



The European Molecular Biology Laboratory is an inter-governmental research institution that operates on the basis of statutes adopted in 1974. The laboratory had 10 founding members, 16 member states and two associated members have additionally joined the organisation. EMBL is currently situated in six locations in five countries. The EMBL employs more than 1,600 people in total (researchers, engineers and support structure) plus 200 doctoral students and 260 postdocs. The EMBL conducts top-level fundamental research, offers training and services through its core laboratories. The organisation currently includes more than 80 functioning research groups and 23 ERC grantees. Employment in the EMBL is limited to nine years, after which researchers have to continue their career in other academic institutions, the private sector or other sectors. Continuous admission of doctoral students (50 per year, mainly from member states), training of postdocs and rotation of employees ensures smooth knowledge transfer from the top research centre back to member states and universities.

Full membership of EMBL allows Estonia to benefit from the European Research Area to a greater degree and access services that it currently lacks or that require improvement,

for example structural biology and accelerator channels; translational medicine and genomics services; bioinformatics and IT services designed for researchers. One important aspect is the member states' better access to the EMBL doctoral and postdoc programmes. Estonia would also benefit from improved access to research equipment, knowledge and training. Membership in EMBL creates new cooperation opportunities for Estonian small and medium-sized enterprises and allows creating direct contacts with global leading large industries that belong to the EMBL network (e.g. pharmaceutical companies). Here, the main areas of interests are the development of personal medicine (incl. personalized cancer medicine) and related entrepreneurship.

EMBL's high competence in analysing genomic data (incl. cancer cells), experience in data retention and expertise in technology transfer improves the development work of Estonian research-heavy companies and their potential for growth. The membership also offers new opportunities for companies that develop new chemicals and materials (EMBL runs one of the largest chemical substance databases in the world) and those active in the field of agrobiolgy (gene banks of farm animals and plants).



Social Sciences and Humanities

Estonian E-repository and Conservation of Collections

Acronym: **e-Varamu**

Lead institution: **University of Tartu**

Partner institutions: **Tallinn University, Estonian Libraries Network Consortium, Estonian Literary Museum, National Library of Estonia, National Archives of Estonia**

Contact person: **Liisi Lembinen, liisi.lembinen@ut.ee**

Website: **www.e-varamu.ee**



E-repository e-Varamu ensures the availability of information resources preserved and created in Estonian research and heritage institutions, which are necessary for R&D and creative activities. Three services are being developed: the digitisation and physical conservation of collections and making information available in the E-repository portal. E-repository supports the sectoral cultural heritage action plan Digitisation of Cultural Heritage 2018–2023.

E-repository infrastructure consists of the following parts.

The E-repository portal makes the digital resources of Estonian heritage institutions—libraries, archives and museums—available electronically. E-repository cooperates with the pan-European web portal Europeana—thus, the information displayed in E-repository is also available via Europeana. The E-repository portal is unique in Estonia. It is a solution that combines different databases and is based on a contemporary search engine, which enables to search all heritage material collected and preserved digitally in Estonia. 12 data sources have joined the E-repository portal and more than 14 million objects have been indexed to date. The portal is developed and managed by the Estonian Libraries Network Consortium.

The digitizing centre of Tallinn University Academic Library uses DL 3003, the most powerful fully automatic scanner in the Baltic States. Its automatic mode can be used to scan both books and large-scale, up to A1-sized publications in the volume of up to three million pages

per year. Digitised files that have been processed with text recognition software are made available via the library's online research library ETERA.

The Estonian Literary Museum's digitisation centre of audio and visual publications has created the conditions for digitising culturally significant audio and visual publications stored on analogue data media, sound and video recording and reproduction. In the framework of the infrastructure, KIVIKE file repository (kivike.kirmus.ee) is being developed to make audio-visual materials available through the E-repository portal. The Estonian Literary Museum is the partner institution of the Center of Estonian Language Resources in developing digital sound and content search engines.

The University of Tartu Library's mass neutralisation centre processes publications of research and heritage value that are printed on excessively acidic paper to prolong their physical life and prevent them from deteriorating. The centre uses the CSC Book Saver mass neutralisation device, which can be used to simultaneously process up to 80 kg of publications with high pH-level.

The further development of the **National Library of Estonia's digital archive DIGAR** allows accepting materials that have been digitised by other institution and created digitally, automatically equipping them with metadata, ensuring the long-term preservation of online publications and access thereto.



Image: Portal e-Varamu

Infotechnological Mobility Observatory

Acronym: **IMO**

Lead institution: **University of Tartu**

Partner institutions: **Tallinn University of Technology, Tallinn University, Statistics Estonia**

Contact person: **Tiit Tammaru, tiit.tammaru@ut.ee**

Website: imo.ut.ee

We are currently living in an era of migration and mobility. More than 250 million people live outside their country of birth and the population of large cities continues to grow even in developed countries. There has also been an increase in the variety of short-term mobility forms both between countries and within countries for reasons such as work, studies, tourism, etc. The increase in mobility brings about both difficulties to emigration countries and regions and creates integration challenges for immigration countries. Mobility also causes inequality, transport and environmental problems. The development of migration policy is thus a relevant topic in Estonia, the European Union and the whole world—let us, for instance, recall the discussions over the Global Compact for Migration in 2018.

IMO creates a comprehensive research data infrastructure for conducting studies of the spatial mobility of the population, using both traditional statistics databases as well as contemporary infotechnological data sources. The unified data infrastructure combines databases that can be used to analyse people's everyday movement, the relationship between spatial mobility and labour market changes and the use of transport, but also long-term changes in the spatial mobility of the population and factors that influence it. Methodological harmonisation, the establishment of data laboratories in partner universities and the creation of a user-friendly remote working environment, which makes the research infrastructure available to a wider audience, play a significant part in the establishment of the data infrastructure.

The University of Tartu Department of Geography has developed a unique longitudinal database of the daily movements of people in Estonia based on mobile tracking. The infrastructure is complemented with GPS data to understand mobility patterns and connections with the environment in more detail. The Faculty of Economics and Business Administration, population and urban geog-



Photo: Dago Antov



Image: Nicole Delpeche-Ellmann

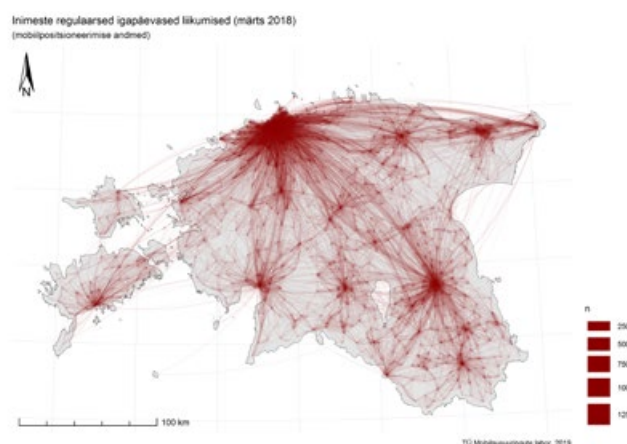


Image: Anto Aasa

raphers at the University of Tartu, the Estonian Institute for Population Studies at Tallinn University and Statistics Estonia have combined individual data from different registers and population surveys into a varied research infrastructure. The most important parts of the existing infrastructure are the individual linked databases of the censuses of 1989, 2000 and 2011 and information from registers, which allow conducting longitudinal analyses on the causes and consequences of migration. Development of employer, employee and company databases creates a basis for economic political studies. The development work by the Ragnar Nurkse Department of Innovation and Governance at TalTech allows analysing and planning the temporal and spatial dynamics of e-residency more precisely. The Research Centre of Logistics and Transportation, Institutes of Cybernetics and the Department of Computer Systems at TalTech conduct transport research and develop datasets related to various (urban) sensors. The research infrastructure has contributed to the expansion of the network of sensors and counting devices, the updating of existing datasets and the creation of new ones, which provide opportunities for the detailed assessment and visualisation of mobility patterns.

Center of Estonian Language Resources

Acronym: **CELR**

Lead institution: **University of Tartu**

Partner institutions: **Tallinn University of Technology, Institute of the Estonian Language, Estonian Literary Museum**

Contact person: **Kadri Vider, kadri.vider@ut.ee**

Website: keeleressursid.ee

The Centre of Estonian Language Resources is a research infrastructure that ensures the availability of digital resources and technology of the Estonian language. The purpose of the centre, which functions as a consortium of the University of Tartu, the Institute of the Estonian Language, Tallinn University of Technology and the Estonian Literary Museum, is to combine existing digital language resources (dictionaries, text and speech corpora and language databases) and language processing tools (software) into mutually functional services equipped with expertise.

In order to facilitate use, the centre combines access to existing digital datasets and offers language technology tools as an online service that uses archived data. In Estonia, the infrastructure is open to language resource owners, developers as well as users. The CELR participates in the pan-European language resources and technology network CLARIN ERIC, which enables European users to access Estonian language resources and language technology tools and Estonian researchers to access similar data in other European countries.

The language resources collected in the CELR repository must be equipped with licences of use. The metadata of resources collected are made automatically processable and available in the register and repository. CELR's technical infrastructure is made up of computing and

recording resources managed by its partner institutions and central services.

The infrastructure mainly offers virtual services (incl. hosting for services related to language resources), advises and trains users in creating, preserving, processing and using digital language resources for research. Researchers can access virtual services that require authentication with a single sign-on using their research institution's user account via TAAT. The CELR language resource register META-SHARE (<https://metashare.ut.ee>) combines information about the metadata of language datasets (incl. information about the DOI, PID, access and licences of use of the resources) and counts resource views and downloads. DataCite Estonia (<http://datacite.ut.ee/services.php>) provides all registered resources with a DOI, which can be used in research publications to refer to a dataset or software. The CELR language resource data repository ENTU (<https://entu.keeleressursid.ee>) stores registered resources for both archiving and use; code repository GitLab (<https://gitlab.keeleressursid.ee/explore/projects>) stores and, where necessary, develops software code. Online services include KORP corpus query service (<https://korp.keeleressursid.ee>), Keeleliin web environment for language processing modules (<http://keeleliin.keeleressursid.ee>) and RABA integrated content search engine (<https://raba.keeleressursid.ee>).

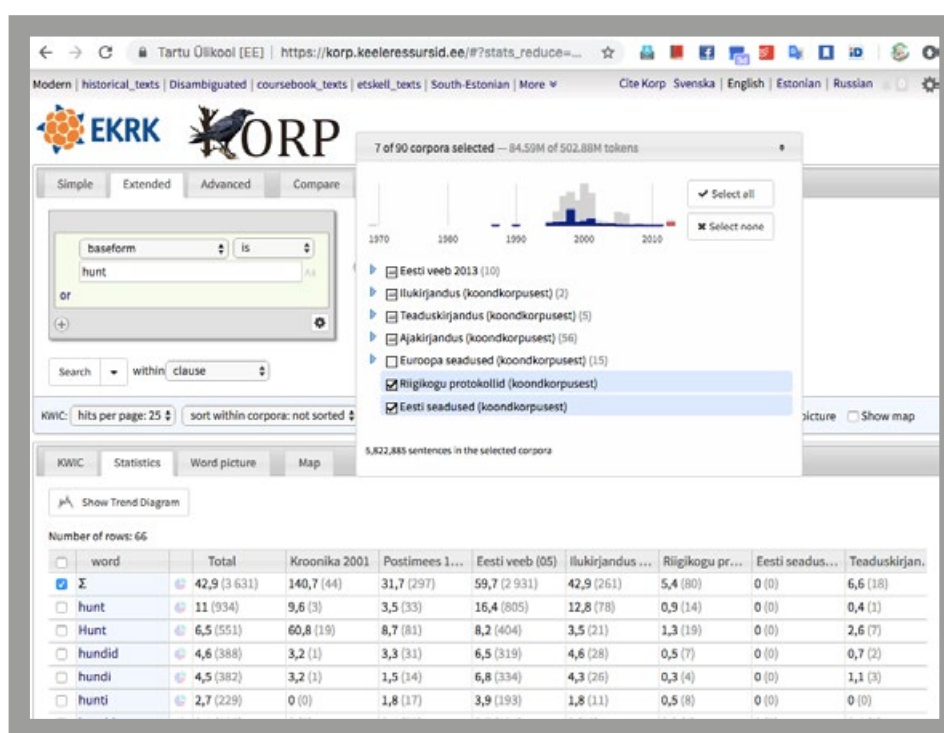


Image: The Centre of Estonian Language Resources

Common Language Resources and Technology Infrastructure

Acronym: **CLARIN ERIC**

Website: www.clarin.eu

Estonia's membership status: founding member (2011)



CLARIN ERIC is a pan-European collaborative effort that makes language resources and technology available and usable as an integrated and interoperable infrastructure. CLARIN consists of governing and coordinating bodies, national consortia, different types of expert centres and web services. All participating organisations offer similar access to digital language datasets and tools for their processing and advise (research) users upon using them. CLARIN makes digital language resources available to scholars, researchers, students and social scientists from

all disciplines, particularly from humanities and social sciences, via single sign-on access. CLARIN offers long-term solutions and technology services for deploying, connecting, analysing and sustaining digital language data and tools.

The technical infrastructure of CELR meets the requirements of CLARIN B-centre, offering and mediating services that comply with CLARIN's quality requirements. All Estonian language resources registered at CELR can be automatically found in CLARIN Virtual Language Observatory (<https://vlo.clarin.eu/>). Estonian language, digital cultural content and data are more visible and widely accessible in the European and international context for both the research community and the public. In turn, membership in CLARIN ERIC gives Estonian researchers full access to digital language and cultural resources of other CLARIN countries. Access to CLARIN resources (data, tools and methods) promotes cross-border and interdisciplinary research, as researchers can build on one another's results at the European level.

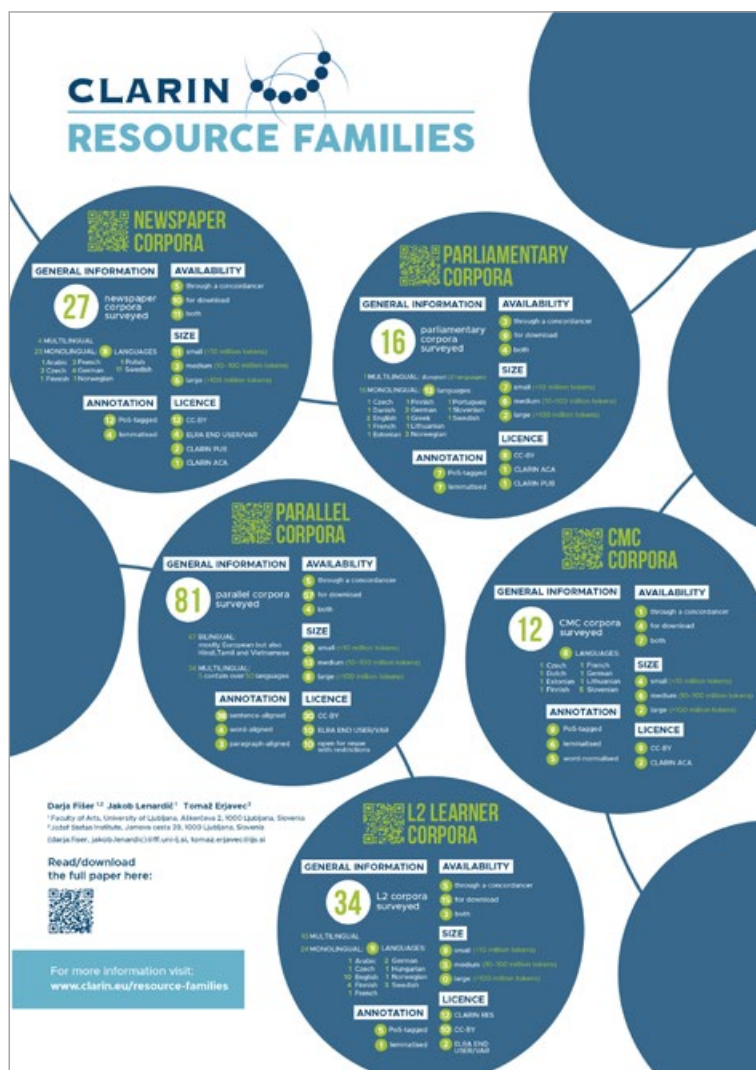


Image: CLARIN ERIC

Estonia in the European Social Survey

Acronym: ESS

Lead institution: University of Tartu

Partner institution: Statistics Estonia

Contact person: Mare Ainsaar, mare.ainsaar@ut.ee

Website: www.yti.ut.ee/et/euroopa-sotsiaaluuring

The European Social Survey is a social science database, which can be used to analyse and explain the development of society and the relationship between people's attitudes and behaviour. ESS collects data every two years from persons aged 15 and older from nearly 30 countries. The data from each round is added to the existing database to compile a dataset describing the long-term development of societies. The core data contain information about, for example, media consumption, health, trust, participation, welfare, socio-political activity and values, with special topics added on different years. The database covers more than 1,000 research topics. In addition to the database, detailed information about the process of data collection and methodology has been made available for public use. Users can download the information collected free of charge via different statistics programmes and an online programme. As of 2012, data can be analysed by statistical regions in Europe. To this end, the data of individuals is equipped with attributes describing people's places of residence.

ESS includes information about 400,000 people from 30 countries. In Estonia, the data of 2,000 people are added to the collection every two years. Estonia's participation

enables to compare the processes in Estonia to other societies. The extension of time series increases the value of the whole database owing to a larger number of topics and longer timelines, which allows for better causal analyses.

Survey data is freely available to everyone at <http://ess.nsd.uib.no>. Around 100 publications are published every year about Estonia using the data from the ESS collection. Estonia's participation in ESS gives Estonian researchers the opportunity to be a part of international research projects that use ESS data. In addition to its research value, survey data can be applied in practice and used actively to analyse the Estonian society and people's behaviours. In January 2019, ESS had 1,855 users in Estonia, including researchers, university students, state institutions, private sector enterprises and non-governmental organisations.

The goal for the next few years is to extend the time series of Estonian data, increase the number of users and improve users' analytical skills. Offering counselling and training to users will help them to analyse data more efficiently and with better quality, increase the number of publications and their influence on research and the development of society.



Image: European Social Survey (ESS ERIC)

European Social Survey

Acronym: **ESS ERIC**

Website: www.europeansocialsurvey.org

Estonia's membership status: founding member (2013)



The European Social Survey is a pan-European research infrastructure providing freely accessible data about people's changing attitudes and behaviour to academics, policymakers, civil society and the public. ESS collects information about people's attitudes and behaviour in every two years, develops a unified database and research methodology, organises training (incl. online) and creates conditions for the open use of data. The research part of the ESS ERIC survey is coordinated in Estonia by the University of Tartu Institute of Sociology and Social Policy.

The ESS Estonia working group coordinates data collection in Estonia and cooperates closely with ESS ERIC in order to ensure the comparability and high quality of data. Participation in ESS ERIC is important to Estonia because of its valuable data, which help to boost the competitive power of researchers. Working with ESS allows Estonian researchers to be up to date and participate in the newest methodological developments in surveys. For example, Estonia has participated in several methodological experiments that were conducted only in selected countries.



Image: European Social Survey (ESS ERIC)

Estonian Generations and Gender Survey 2020

Acronym: GGS2020-EE

Lead institution: Tallinn University

Partner institutions: University of Tartu, Statistics Estonia, Ministry of Social Affairs

Contact person: Allan Puur, allan.puur@tlu.ee

Website: www.ggp-i.org

Estonian Generations and Gender Survey 2020 is an academically-driven social science database that provides new internationally comparable data for the analysis of contemporary demographic developments in Estonia and policymaking. Although welfare indices show that Estonians have never been so well-off as they are now, fertility levels are below replacement levels in Estonia, as in most other European countries. In the long term, this gives rise to concerns that the society may face a prospect of being locked into a depopulation spiral which can be difficult to escape. Given the issues associated with large-scale immigration, fertility and family dynamics deserve close attention in the search for a more sustainable society.

The evidence provided by statistical bodies allows monitoring the general trends in demographic processes but proves insufficient for understanding them comprehensively. Specialised surveys organised simultaneously in many countries using a unified programme and methodology have become the main source of information required for studying birth rates and family processes. GGS2020-EE includes Estonian participation in the upcoming international comparative study Generations and Gender

Programme (GGP) 2020, including the preparation and organisation of a national study and making the data collected available to users. The last similar survey held in Estonia took place 15 years ago and since then, new generations have reached the age of starting a family, but we lack detailed information on their family and fertility behaviour. Such information is needed in society for both understanding changes in population processes and policy-making.

The main service provided by the infrastructure is the new high-quality internationally comparable longitudinal dataset for the analysis of fertility and family dynamics. The datasets of Estonia and other countries as well as supporting documentation are available to a wide audience including researchers, degree students and policymakers (incl. ministry analysts) via the programme's international web environment (<https://www.ggp-i.org/>). Currently, the environment offers access to datasets of the previous GPP round held in the 2000s, incl. about Estonia. The results of the Estonian survey are to be made available via the online database of Statistics Estonia.



Image: Shutterstock, Inc

Generations and Gender Programme

Acronym: **GGP2020**

Website: **www.ggp-i.org**

Estonia's membership status: pending



The Generations and Gender Programme 2020 is an international social science research data collection that provides up to date internationally comparable data for the analysis of contemporary fertility and family dynamics in Europe and policy-making. GGP2020 is an international survey based on unified programme and methodology. The survey consists of three sets of panels, in which the same respondents are monitored for a total of six years. The use of panel design significantly extends the scope of factors whose influence on demographic behaviour can be analysed with the help of the infrastructure. These include the respondents' economic situation, attitudes, gender roles, intergenerational relations, work-family balance, division of housework, health, wellbeing, etc.

GGP also collects retrospective information on respondents' previous life, incl. their childbearing and partnership histories. Participation in GGP2020 provides Estonia access to state-of-the-art solutions developed via international cooperation for the survey programme, methodology and procedures. Once the data are collected, the infrastructure allows users to analyse contemporary family and fertility dynamics in Estonia in comparison with many other countries. The programme contributes to Estonian researchers' participation in international research cooperation and supports research-based degree studies in social studies that use quantitative methods. Estonia, just as other participating countries, is expected to apply for funding for a national GGP survey, prepare and conduct the survey, publish its findings and advise users.

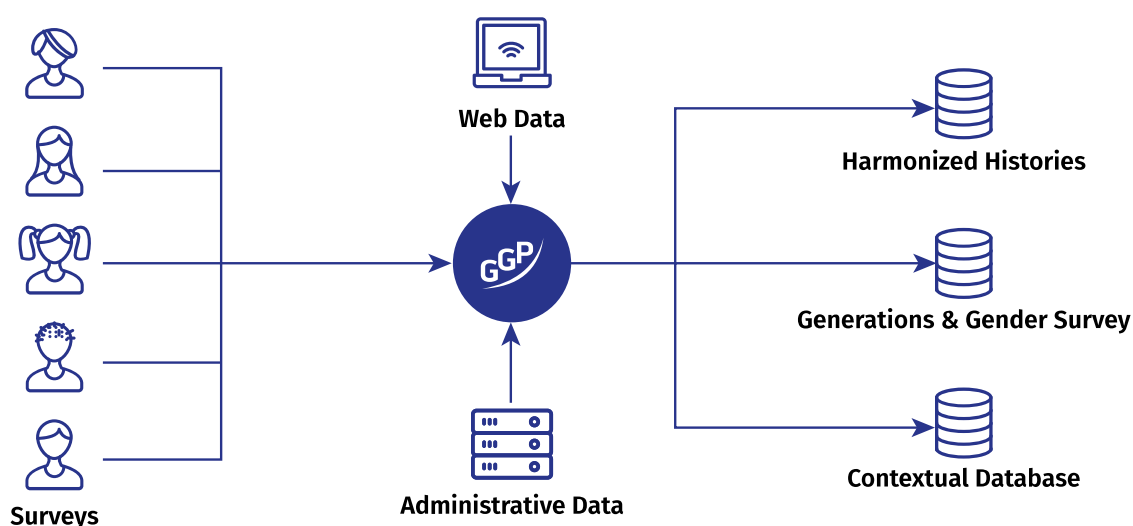


Image: GGP2020



E-Infrastructures



Estonian Research and Education Optical Backbone Network

Acronym: **EENet**

Lead institution: **Information Technology Foundation for Education**

Contact person: **Kristina Lillemets, kristina.lillemets@hitsa.ee**

Website: **www.eenet.ee/EENet/optikavork**

The Estonian Education and Research Network serves as a basic infrastructure for all research and development institutions and research infrastructures that call for cross-border cooperation, fast data transfer and forwarding of large data volumes. The network ensures the functioning of a data network compatible with the needs of Estonian research and education and its compatibility with new innovative projects. The network is connected to GÉANT, a pan-European network of research and development institutions, via the network nodes of Tallinn and Tartu. GÉANT connects more than 50 million users from over 10,000 European research institutions and is directly connected to research networks of other continents, uniting researchers from more than 100 countries.

The optical backbone is comprised of ca. 1,200 km of optical fibre cable in Estonia and 100 km connecting Tallinn and Espoo, 20 optical nodes, 4 network nodes in Tallinn and 3 network nodes in Tartu plus smaller nodes in counties.

The network's current speed is 4×10 Gbit/s and 100 Gbit/s between Tallinn and Tartu. In theory, up to 80 channels with a network speed of 100 Gbit/s can be put into service without increasing fixed costs.

The main function of the infrastructure object is to offer Estonian institutions of higher education and research necessary contemporary data connection, through which the Estonian academic community can access the newest data connection solutions and the most demanding

Internet services. Fast data connection enables Estonian researchers to participate in large-scale projects and research fields that involve large-scale data transfers and processing regardless of their location, thus increasing the competitiveness of Estonian R&D and facilitating international cooperation. Employees of Estonian R&D institutions require a data service that involves considerably greater volumes and higher quality compared to average connections in many STEM fields, e.g. genetics, sequencing, evolutionary biology, embryo technology, bioinformatics, computational chemistry, physics, materials sciences, astronomy, data mining, distributed systems, language technology, forecasting and modelling of maritime systems, wave mechanics, speech recognition, topography and architecture. The optical backbone is also required for Estonia's participation in the experiments of the European Organization for Nuclear Research (CERN). The backbone enables Estonian researchers to make data flows from Earth monitoring satellites sent to orbit as part of the EU Earth Observation Copernicus Programme available via the GÉANT network.

The optical backbone is used by many other Estonian research infrastructures in their work, for instance, the Estonian Scientific Computing Infrastructure (ETAIS), the Natural History Archives and Information Network (NATARC), the Center of Estonian Language Resources (CELR), the Estonian Environmental Observatory (KKobs), the National Center for Translational and Clinical Research (CTM), the Estonian Center for Genomics (ECG), Estonian participation in CERN and the European Space Agency (ESA).



Image: Urmas Lett

Estonian Scientific Computing Infrastructure

Acronym: ETAIS

Lead institution: University of Tartu

Partner institutions: Tallinn University of Technology, National Institute of Chemical Physics and Biophysics, Information Technology Foundation for Education

Contact person: Ivar Koppel, ivar.koppel@ut.ee

Website: etais.ee

The Estonian Scientific Computing Infrastructure is a nationwide unified infrastructure of science computation, which consists of scientific computation centres, the computation clusters therein, supercomputers and data repositories, central services connecting the centres and resources, people specialised in programming and the training of end users. The services are freely available to all R&D institutions and research-based enterprises. The ETAIS is managed by the Council of the ETAIS consortium while the infrastructure's daily work is supported by the IT departments of the relevant institutions or special departments dedicated to scientific computation.

The task of ETAIS is to offer a comprehensive solution for scientific data processing issues, incl. to ensure storage capacity and analysis capability, support field-specific applications, data management during their whole life cycle and exchange of expertise. ETAIS also serves as a gateway between Estonian e-infrastructures and foreign partners. ETAIS is currently an observer at the Nordic e-Infrastructure Collaboration (NeIC) and cooperates actively with international research infrastructures such as the European Open Science Cloud (EOSC) and the European High-Performance Computing Joint Undertaking (EuroHPC JU). The Waldur environment established by ETAIS is currently being tested in the Nordic countries and development is ongoing for its expansion and the organisation of the joint use of other research equipment. ETAIS is mainly used by researchers in the fields of bioinformatics and personal medicine, data mining, language technology, chemical and materials sciences, climate studies and linguistics.

ETAIS currently manages 16,000 cpu cores, more than 10 PB of storage capacity, 30 GPUs and up to 30 PB of archival capacity on tapes. Centres related to ETAIS employ over 20 specialists. ETAIS offers users cloud services, classical scientific computing (HPC – high performance computing) services, research application hosting and

management services and resource ensuring services for repositories. ETAIS services seven roadmap objects directly. ETAIS covers the infotechnological needs of the Center of Estonian Language Resources, ELIXIR Estonia, the Estonian Center for Genomics, the National Center for Translational and Clinical Research and the Estonian Center of Analytical Chemistry.



Photo: Andres Tennus

Nordic e-Infrastructure Collaboration



Acronym: **NeIC**

Website: **neic.no**

Estonia's membership status: observer since 2018; full membership pending

NeIC is a cooperation organisation operating under NordForsk, a research organisation under the Nordic Council of Ministers, the purpose of which is to develop and operate world class e-infrastructures in fields that are of interest to the Nordic countries. NeIC is a distributed organisation that includes experts from all Nordic scientific computation centres. Its national partner organisations include CSC (Finland), SNIC (Sweden), UNINETT Sigma2 (Norway) DeIC (Denmark) and RH Net (Iceland). NeIC aims to become the world's largest provider of cross-border e-infrastructure services.

Estonia's full membership contributes significantly to international cooperation and increasing Estonia's scien-

tific computation capacity. The University of Tartu Natural History Museum (DeepDive—Nordic-Baltic Collaboration on e-Infrastructures for Biodiversity Informatics) and ETAIS (Dellingr2—Nordic Collaboration on Resource Sharing) are already participating in NeIC projects. In the future, ETAIS plans to join Glenna 2 (Nordic cloud collaboration) and Tryggve2 (Nordic collaboration for sensitive BMS research data) projects, which are also linked to ELIXIR Estonia and the Estonian Center for Genomics. The Nordic WLCG tier 1 Facility project is consistent with Estonia's planned membership in the European Organization for Nuclear Research. The Center of Estonian Language Resources has expressed interest in participating in the Nordic Language Processing Laboratory.

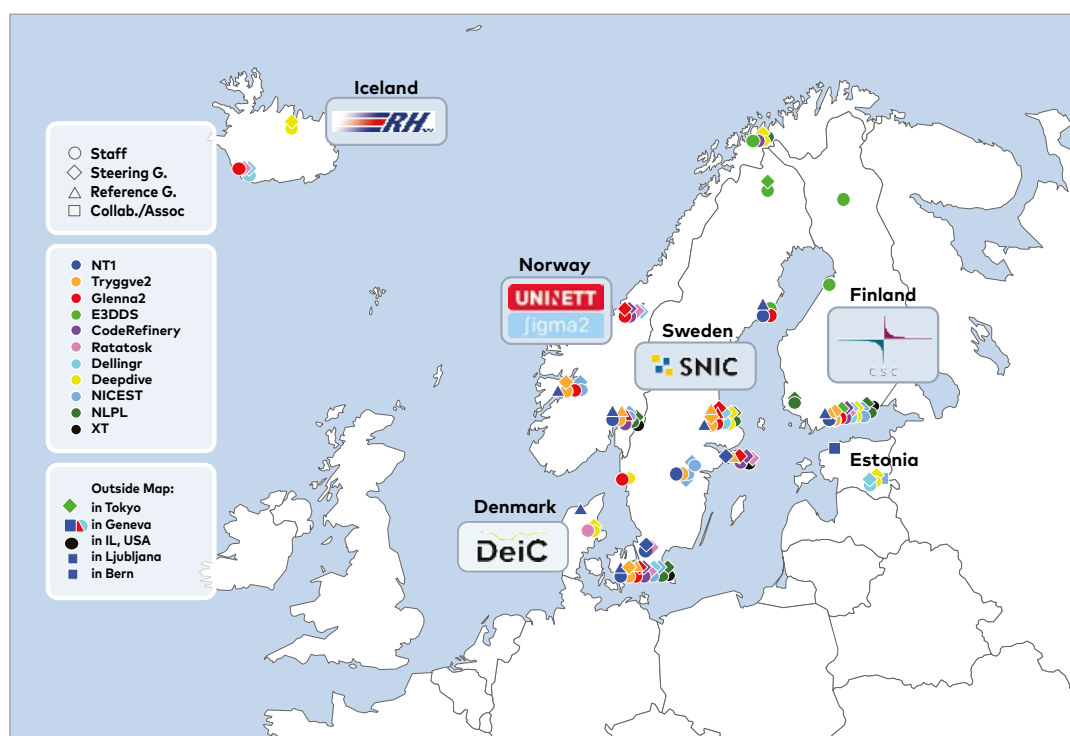


Image: NeIC

Annex

The order of the Government of the Republic No. 43 from 14 February 2019.

List of objects included in the Estonian Research Infrastructure Roadmap

No.	Name of object	Participating institutions
PLANNED RESEARCH INFRASTRUCTURES		
1	Estonian Center of Analytical Chemistry	University of Tartu (Lead institution), Tallinn University of Technology, Estonian Environmental Research Centre, National Institute of Chemical Physics and Biophysics
2	Estonian Center for Genomics	University of Tartu (Lead institution)
3	Center of Estonian Language Resources	University of Tartu (Lead institution), Tallinn University of Technology, Institute of the Estonian Language, Estonian Literary Museum
4	Estonian node of European Life-sciences Infrastructure for Biological information (ELIXIR)	University of Tartu (Lead institution), Tallinn University of Technology, National Institute of Chemical Physics and Biophysics, National Institute for Health Development
5	Estonian Scientific Computing Infrastructure	University of Tartu (Lead institution), Tallinn University of Technology, National Institute of Chemical Physics and Biophysics, Information Technology Foundation for Education
6	Estonia in the European Social Survey	University of Tartu (Lead institution), Statistics Estonia
7	Infotechnological Mobility Observatory	University of Tartu (Lead institution), Tallinn University of Technology, Tallinn University, Statistics Estonia
8	Center of Nanomaterials Technologies and Research	University of Tartu (Lead institution), Tallinn University of Technology, National Institute of Chemical Physics and Biophysics
9	Natural History Archives and Information Network	University of Tartu (Lead institution), Tallinn University of Technology, Estonian University of Life Sciences, Tallinn University, Estonian Museum of Natural History, Environment Agency, Environmental Board
10	National Center for Translational and Clinical Research	University of Tartu (Lead institution), Estonian University of Life Sciences, Tartu University Hospital
11	Plant Biology Infrastructure	University of Tartu (Lead institution), Estonian University of Life Sciences, Tallinn University of Technology, Estonian Crop Research Institute
12	Estonian Generations and Gender Survey 2020	Tallinn University (Lead institution), University of Tartu, Statistics Estonia, Ministry of Social Affairs
13	Marine Technology and Hydrodynamics Research Infrastructure	Tallinn University of Technology (Lead institution), Baltic Workboats AS, Association of Estonian Marine Industries
14	Smart Industry Centre	Tallinn University of Technology (Lead institution), Estonian University of Life Sciences, University of Tartu
IMPLEMENTED RESEARCH INFRASTRUCTURES		
1	Estonian E-repository and Conservation of Collections	University of Tartu (Lead institution), Tallinn University, Estonian Libraries Network Consortium, Estonian Literary Museum, National Library of Estonia, National Archives of Estonia
2	Estonian Environmental Observatory	University of Tartu (Lead institution), Estonian University of Life Sciences, Tallinn University of Technology, Tallinn University
3	Estonian Research and Education Optical Backbone Network	Information Technology Foundation for Education (Lead institution)

ESTONIAN PARTICIPATION IN INTERNATIONAL RESEARCH INFRASTRUCTURE ORGANISATIONS

No.	Name of international research infrastructure organisation	Name of related Estonian research infrastructure object
1	BBMRI ERIC: Biobanking and Biomolecular Resources Research Infrastructure	Estonian Center for Genomics
2	CLARIN ERIC: Common Language Resources and Technology Infrastructure	Center of Estonian Language Resources
3	ELIXIR: European Life-sciences Infrastructure for Biological information	Estonian node of European Life-sciences Infrastructure for Biological information (ELIXIR)
4	NeIC: Nordic e-Infrastructure Collaboration	Estonian Scientific Computing Infrastructure
5	ESS ERIC: European Social Survey	Estonia in the European Social Survey
6	ICOS ERIC: Integrated Carbon Observation System	Estonian Environmental Observatory
7	AnaEE: Analysis and Experimentation on Ecosystems	Estonian Environmental Observatory
8	DiSSCo: Distributed Systems of Scientific Collections	Natural History Archives and Information Network
9	GGP2020: Generations and Gender Programme	Estonian Generations and Gender Survey 2020
10	Estonian-Finnish beamline at MAX-IV Synchrotron Radiation Source (FinEstBeAMS)	
11	European Spallation Source ERIC	
12	European Space Agency (ESA)	
13	European Organization for Nuclear Research (CERN)	
14	European Molecular Biology Laboratory (EMBL)	

The direct connections to smart specialisation strategy of the objects included in the Estonian Research Infrastructure Roadmap

The following objects contribute directly to achieving the aims of smart specialisation strategy:

- Estonian Research and Education Optical Backbone Network
- Estonian Center for Genomics
- Center of Estonian Language Resources
- Center of Nanomaterials Technologies and Research
- National Center for Translational and Clinical Research
- Estonian Center of Analytical Chemistry
- European Life-sciences Infrastructure for Biological information (ELIXIR)
- Infotechnological Mobility Observatory
- European Space Agency (ESA)
- Smart Industry Centre

The following objects contribute partially to achieving the aims of smart specialisation strategy:

- Estonian Scientific Computing Infrastructure
- Estonian E-repository and Conservation of Collections
- Estonian-Finnish beamline at MAX-IV Synchrotron Radiation Source
- European Spallation Source ERIC
- Marine Technology and Hydrodynamics Research Infrastructure



