RCL

Research Council of Lithuania

2024

LITHUANIAN RESEARCH INFRASTRUCTURES ROADMAP

LITHUANIAN RESEARCH INFRASTRUCTURES ROADMAP 2024

Publishing House “Kriventa”
Vilnius, 2025

Bibliographic information is available on the Lithuanian Integrated Library Information System (LIBIS) portal: ibiblioteka.lt

ISBN 978-609-462-262-5 (pdf)

TABLE OF CONTENTS

FOREWORD

Dear colleagues,

Research infrastructure (RI), the essential tangible and intangible tools and instruments that guarantee the greatest level of research, experimental development and innovation, are being strengthened and developed as we continue our purposeful journey towards national advancement. I am pleased to present the fourth edition of the RI Roadmap, a crucial document that offers a thorough analysis and critical evaluation of the existing state of affairs while formulating a strategic plan for the advancement of RI in our country. It embodies a long-term vision and reflects the persistent efforts of the Research Council of Lithuania, the country's important social partners, the Lithuanian scientific community and qualified foreign experts to implement the ambitious goals of our country's progress.

The history of the development of the Lithuanian RI demonstrates the scientific community's resolute commitment to joining the global, mainly European Union, research community, collaborating with top international research centres and organisations, and providing new avenues for Lithuanian researchers and scientists to implement the most cutting-edge scientific concepts and technological advancements. The logically planned development of national RIs has opened new avenues for consistent and productive cooperation with the world's strongest scientific teams, created new opportunities for retaining talent in Lithuania, expanded the cognitive horizons and the culture of innovation by working with renowned researchers from other countries and more. This is evident after Lithuania signed international treaties and agreements on membership in international RIs organisations, and Lithuanian researchers gained some experience in joint projects with international organisations such as CERN, EMBL, ELI ERIC, INSTRUCT-ERIC and SHARE-ERIC.

More than a decade since the first Lithuanian RI Roadmap was published in 2011, we are witnessing a marked improvement in RI, along with new prospects brought about by the quick growth of digital technologies, particularly artificial intelligence. It is also clear that a culture of sharing the use of valuable research complexes and other resources is emerging. This document serves as a roadmap for our dedication to finding precise, audacious and long-lasting solutions to establish a cutting-edge research and innovation environment in Lithuania. An ecosystem where the ideas of every talented Lithuanian researcher will have every opportunity to transform into the new knowledge, competencies and innovations necessary to ensure the social, economic and cultural development of our country and its international competitiveness.

In addition to offering insights into the future of RIs, the process of preparing this paper has brought about some significant shifts in public administration that are fostering a culture of trust in the construction of RIs. The creation of this strategy plan, the widespread participation of social partners and the ongoing observation and assessment of the RIs development processes are all made possible by improved legislation on the drafting of the Roadmap. This, in our opinion, enhances the document's political role, guarantees that strategic planning procedures are compatible with those of developed nations and lastly, strengthens Lithuanian RIs' position concerning the growth of international networks. This in turn encourages participation from our scientific communities, who frequently serve as the organisers and initiators of international research projects and compete on a global scale.

Although the Roadmap is a document produced by a relatively limited number of stakeholders, the success of its implementation depends on the active involvement of all of us – the scientific community, the social partners and especially the business community. We understand that a sustainable future and a modern, competitive economy are the result not only of the state but also of the active participation of every citizen and every community. We therefore hope that the implementation of this document will contribute to increasing public participation in the creation and development of scientific knowledge, identifying the most important challenges and tasks that we can address with state-of-the-art scientific research tools, instruments and resources. We also hope that the Roadmap will develop the country's human potential in science, foster innovations in education and training for sustainable progress and social cohesion, and enable citizens to feel that they are full contributors to our country's progress. I thank all those who have contributed to this document and those who are ready to work together to build Lithuania's future.

Gintaras Valinčius
Chairman of the Research Council of Lithuania

ACKNOWLEDGEMENTS

The Lithuanian Research Infrastructures Roadmap 2024 (Roadmap) is the result of a long and complex process. Many experts have been involved in the preparation of this publication and without their input the Roadmap would be difficult to imagine.

The Research Council of Lithuania expresses its sincere gratitude Dr Giedrius Viliūnas, Dr Edita Bagdonaitė, Prof. Saulė Mačiukaitė-Žvinienė, Gerinta Raguckaitė, Prof. Virginijus Šikšnys and Prof. Eugenijus Butkus, who helped to prepare the legal environment for their contributions in shaping the legal framework necessary for the development of the Roadmap, as well as for establishing the criteria for the evaluation of the applications and designing the application form.

The working group, headed by Dr Giedrius Viliūnas, successfully produced the first and second parts of the Roadmap in a relatively short time, considering the magnitude of the work. The group consisted of Dr Jelena Angelis, Prof. Gediminas Brazaitis, Dr Mindaugas Gilaitis, Prof. Saulius Keturakis, Prof. Arūnas Poviliūnas, Prof. Minvydas Kazys Ragulskis, Prof. Saulė Mačiukaitė-Žvinienė, Dr Vacis Tatarūnas, Prof. Gražina Tautvaišienė and Dr Rūta Žiliukaitė. Special thanks go to Dr Mindaugas Gilaitis, who is the main author of the text.

Without the two expert panels, which carried out the threshold and comprehensive assessment of the applications professionally and seamlessly, this Roadmap would not exist. My sincere gratitude is extended to them, although their identities remain confidential.

For their thoughts and suggestions that helped to improve the quality of the Roadmap, we offer our genuine gratitude Tadas Juknevičius, Dr Liutauras Kraniauskas, Prof. Arūnas Poviliūnas, Dr Laima Taparauskienė, Prof. Gintaras Valušis and Prof. Petras Rimantas Venskutonis.

The process of preparing the Roadmap was coordinated by Dr Eugenijus Stumbrys, Head of the Research and Higher Education Policy Analysis Unit of the Research Council of Lithuania, and Indrė Nazarenko, Research Policy Analyst. Their contribution was essential in ensuring the accuracy of the information and fostering a productive working atmosphere throughout the process. Special thanks also are also extended to Dr Vaiva Priudokienė, Deputy Chair of the Research Council of Lithuania, whose unwavering attention facilitated the prompt validation of the Roadmap preparation processes.

The Research Council of Lithuania gratefully acknowledges all those who are not explicitly named here but have played a role in supporting the preparation and release of the Roadmap.

ABBREVIATIONS

ACTRIS ERIC	–	Aerosol, Clouds and Trace Gases Research Infrastructure – European Research Infrastructure Consortium
AEROINFRA	–	National Aerobiological Research Infrastructure
AGBC	–	Augalų genetikos ir biotechnologijų centras – Centre for Plant Genetics and Biotechnologies
AnaEE-ERIC	–	Analysis and Experimentation on Ecosystems – European Research Infrastructure Consortium
BBMRI-ERIC	–	Biobanking and BioMolecular Resources Research Infrastructure – European Research Infrastructure Consortium
BIGIS	–	Biologinės įvairovės geografinės informacinės sistemos (Biodiversity Geographic Information Systems)
BioDatCom Centre	–	Biodiversity and Geodiversity Data Centre
BPTI	–	Baltijos pažangių technologijų institutas (Baltic Institute of Advanced Technology)
CERIC ERIC	–	Central European Research Infrastructure Consortium European Research Infrastructure Consortium
CERN	–	Conseil Européen pour la Recherche Nucléaire (European Council for Nuclear Research)
CESSDA-ERIC	–	Consortium of European Social Science Data Archives – European Research Infrastructure Consortium
CETAF	–	Consortium of European Taxonomic Facilities
CLARIN ERIC	–	Common Language Resources and Technology Infrastructure Network – European Research Infrastructure Consortium
CLARIN-LT	–	Common Language Resources and Technology Infrastructure Network – Lithuania
CLIMAGRO LT	–	Climate-Smart Regenerative and Precision Agriculture Research Infrastructure – Lithuania
CMS	–	Compact muon solenoid
CNRS	–	Centre national de la recherche scientifique (National Scientific Research Centre)
CossyBio	–	Centre for Computational, Structural and Systems Biology
CPTS	–	Centre for Physical and Technological Sciences
DARIAH ERIC	–	Digital Research Infrastructure for the Arts and Humanities – European Research Infrastructure Consortium
DCDR	–	Data, computing and digital research
DiSSCO	–	Distributed System of Scientific Collections
DNRIC	–	Directors of National Research Institutes Conference
EARTO	–	European Association of Research and Technology Organisations
EARLINET-ASOS	–	European Aerosol Research Lidar Network – Advanced Sustainable Observation System

EBRAINS	–	European Brain Research Infrastructures
EBRAINS-LT	–	European Brain Research Infrastructures – Lithuania
EERA	–	European Energy Research Alliance
EFI	–	European Forest Institute
EFIS	–	European Future Innovation System
EGI	–	European Grid Infrastructure
EIROforum	–	European Intergovernmental Research Organisation Forum
ELI ERIC	–	Extreme Light Infrastructure – European Research Infrastructure Consortium
ELI-LT	–	Extreme Light Infrastructure – Lithuania
EMBC	–	European Molecular Biology Conference
EMBL	–	European Molecular Biology Laboratory
EMBO	–	European Molecular Biology Organisation
EMPHASIS	–	European Infrastructure for Multi-Site Plant Phenomics and Simulation
EMBRC	–	European Marine Biological Resource Centre
EMBRC ERIC	–	European Marine Biological Resource Centre – European Research Infrastructure Consortium
Env	–	Environment
ERIC	–	European Research Infrastructure Consortium
ESA	–	European Space Agency
ESFRI	–	European Strategy Forum on Research Infrastructures
ESO	–	European Southern Observatory
ESReDA	–	European Safety, Reliability and Data Association
ESRF	–	European Synchrotron Radiation Facility
ESS	–	European Social Survey
ESS ERIC	–	European Social Survey – European Research Infrastructure Consortium
EST EMTIK	–	Europos socialinis tyrimas, Europos mokslinių tyrimų infrastruktūros konsorciumas (European Social Survey, European Research Infrastructure Consortium)
EST LT	–	Europos socialinis tyrimas – Lietuva (European Social Survey – Lithuania)
EUFAR	–	European Facility for Airborne Research
EuroHPC	–	European High-Performance Computing
EuroNanoLab	–	European Nanotechnology Laboratory
European XFEL	–	European X-Ray Free-Electron Laser
EuroQCI	–	European Quantum Communication Infrastructure
FAIR principles	–	Findable, Accessible, Interoperable and Reusable principles
GGP	–	Generations and Gender Programme
GGP LT	–	Generations and Gender Programme – Lithuania
GSO Framework	–	Group of Senior Officials Framework
GSO on GRIs	–	Group of Senior Officials on Global Research Infrastructures
HBRC	–	Human Biological Resources Centre
HF	–	Health and food
HLUHS KK	–	Hospital of Lithuanian University of Health Sciences Kauno Klinikos
HPC	–	High-performance computing
HSS	–	Humanities and social sciences

ICOS ERIC	–	Integrated Carbon Observation System – European Research Infrastructure Consortium
ILL	–	Institut Laue-Langevin
ILLF	–	Institute of Lithuanian Literature and Folklore
ILTER/eLTER	–	International Long-Term Ecological Research / Integrated European Long-Term Ecosystem, Critical Zone and Socio-ecological Research Infrastructure
IMC	–	Innovative Medicine Centre
INECOM	–	Institut National d'Ecologie et de Chimie Organique de Montpellier (Infrastructure for Ecological Metabolomics)
INFRAFRONTIER ERIC	–	European Research Infrastructure for Modelling Human Diseases, European Research Infrastructure Consortium
INNOCHEM	–	Innovative Chemistry
INSTRUCT-ERIC	–	Integrated Structured Biology – European Research Infrastructure Consortium
ITER	–	International Thermonuclear Experimental Reactor
IUFRO	–	International Union of Forest Research Organizations
JET	–	Joint European Torus
KEF	–	Knowledge Economy Forum
KH LUHS	–	Kaunas Hospital of the Lithuanian University of Health Sciences
KU	–	Klaipėda University
KUH	–	Klaipėda University Hospital
KTU	–	Kauno technologijos universitetas (Kaunas University of Technology)
LAMMC	–	Lietuvos agrarinių ir miškų mokslų centras (Lithuanian Research Centre for Agriculture and Forestry)
Laserlab-Europe	–	Laser Facilities Research Infrastructure – Europe
LDFK	–	Lietuvos dalelių fizikos konsorciumas (Lithuanian Particle Physics Consortium)
LEI	–	Lithuanian Energy Institute
LHCb	–	Large Hadron Collider beauty
LiDA	–	Lithuanian Data Archive
LifeWatch ERIC	–	European Infrastructure for Biodiversity and Ecosystem Research – European Research Infrastructure Consortium
LISS	–	Longitudinal Internet Studies for the Social Sciences
LIST	–	Lietuvos ilgalaikis socialinis tyrimas (Lithuanian Longitudinal Social Survey)
LitGrid-HPC	–	Lithuanian Grid Infrastructure for High-performance Computing
LR	–	Lietuvos Respublika (Republic of Lithuania)
LRC VU	–	Laser Research Centre, Vilnius University
LRPK	–	Lietuvos Respublikos Prezidento Kanceliarija (Office of the President of the Republic of Lithuania)
LRVK	–	Lietuvos Respublikos Vyriausybės Kanceliarija (Office of the Government of the Republic of Lithuania)
LTA TI / LFA IR	–	Lietuvių tautosakos archyvo tyrimų infrastruktūra (Lithuanian Folklore Archive Database Research Infrastructure)
LTRF	–	Lietuvių tautosakos rankraštyno fondas (Lithuanian Folklore Archive Fund)

LTRFt	–	Lietuvių tautosakos rankraštyno fototeka (Lithuanian Folklore Archive Photo Library Fund)
LTRV	–	Lietuvių tautosakos rankraštyno videoteka (Lithuanian Folklore Archive Video Material)
LUHS	–	Lithuanian University of Health Sciences
LURC	–	Lithuanian University Rectors' Conference
MEDem	–	Monitoring electoral democracy
MEDem LT	–	Monitoring electoral democracy – Lithuania
MEI	–	Ministry of the Economy and Innovation
MNAC	–	Mikro-, nanotechologijų ir analizės atviros prieigos centras (Micro-, Nanotechnology and Analysis Open Access Centre)
MRU	–	Mykolas Romeris University
NBPPN	–	North-Baltic Plant Phenotyping Network
NCI	–	National Cancer Institute
NEMUNIUS-RI	–	Baltic Sea Division of the International Centre for Advanced Studies on River-Sea Systems, Research Infrastructure
NPPN	–	Nordic Plant Phenotyping Network
NREL	–	National Renewable Energy Laboratory
NRC	–	Nature Research Centre
OLED	–	Organic light-emitting diode
OAC	–	Open Access Centre
PHENOPlant	–	Plant Phenotyping Infrastructure for Sustainable Production of Functional Food (Research Infrastructure)
PSE	–	Physical Sciences and Engineering
QUARTIC	–	Resilience to Cyber Threats (Research Infrastructure)
RCL	–	Research Council of Lithuania
RDI	–	Research, Development and Innovation
REFRESH	–	Research Infrastructure for Functional Materials for Sustainable Energy, Environment, and Health
REPowerEU	–	The European Union's Energy Transition Plan
RI	–	Research infrastructure
RILAD	–	Eksperimentinių gyvūnų mokslinių tyrimų infrastruktūra ligų modeliavimui (MTI) (Experimental Animal Research Infrastructure for Disease Modelling)
SDA	–	State Data Agency
SDG	–	Sustainable Development Goals
SERISS	–	Synergies for Europe's Research Infrastructures in the Social Sciences
SHARE-ERIC	–	Survey of Health, Ageing and Retirement in Europe – European Research Infrastructure Consortium
SHARE Lietuva	–	Survey of Health, Ageing and Retirement in Europe – Lithuania
SKAO	–	Square Kilometre Array Observatory
SNETP	–	Sustainable Nuclear Energy Technology Platform
SSH	–	Social Sciences and Humanities
SSHOC	–	Social Sciences and Humanities Open Cloud

SWOT	–	Strengths, Weaknesses, Opportunities and Threats
STRATA	–	Government Strategic Analysis Centre
MESS	–	Ministry of Education, Science and Sport
TESTA	–	Trans-European Services for Telematics between Administrations
UNCTAD	–	United Nations Conference on Trade and Development
UNEP	–	United Nations Environment Programme
UNU	–	United Nations University
VGTU	–	Vilnius Gediminas Technical University
VLRIs	–	Very Large Research Infrastructures
VMU	–	Vytautas Magnus University
VU	–	Vilnius University
VUES	–	Vilnius University Echelle Spectrograph
VUH SK	–	Vilnius University Hospital Santaros Klinikos
VU MAO	–	Vilnius University Molėtai Astronomical Observatory
WET	–	Whole Earth Telescope

SUMMARY

This publication is the fourth edition of the Lithuanian RI Roadmap, which is based on the principles of the European Strategy Forum on RI (ESFRI). Its purpose is to describe the Lithuanian RI ecosystem, the factors and opportunities that determine its development, and to propose long-term RI policy directions and priorities. The Roadmap includes a list of Lithuanian RIs selected by experts, which are proposed to be prioritised for public investment planning and involvement in international RI consortia.

RI is understood as: a set of tools, resources and related services used by the scientific community to conduct research in relevant scientific fields. RI includes scientific equipment, research materials, knowledge resources such as collections, archives and structured scientific information; information and communication technology-based infrastructures such as the GRID network, hardware, software and communication tools, and any other exceptional facilities that are essential for the performance of high-level RDI activities. [1]

The Roadmap is composed of three parts. The first part, History and Future Prospects of Lithuanian RI, discusses the concept, meaning and classification of RI. It emphasises that, in addition to the physical infrastructure, RI activities require enabling research teams, information resources and certain modes of operation – the services that RI provides to the research community. Without state-of-the-art technology and knowledge, the development of today's knowledge and its application to the advancement of society and the economy is unthinkable. RI can be classified according to physical concentration (distributed, networked and digital), maturity level (potential, mature and established), as well as scale and impact (institutional, inter-institutional, strategic, national and international). All types of RI are important for the science ecosystem, and all need to be addressed in a national RI policy.

The origins of modern RI can be traced back to the Cold War-era phenomenon of 'big science', which emerged from the competition between global military-political blocs. In today's world, major RI is very often developed in cooperation between many countries, to share the burden of investment needed to develop and maintain RI, pool the best scientific capabilities and obtain the highest added value from the results of research. The European Union (EU) adheres to these principles following the creation of a special international legal status of European RI Consortium (ERIC) for the most important European RIs selected by the ESFRI Forum and included in the European RI Roadmap. Other intergovernmental fora and global organisations, such as EIROforum, the OECD and the UN, are also involved in the development of international RI.

The preconditions of the Lithuanian RI ecosystem started to develop in the research base of higher education institutions and research institutes of the First Republic of Lithuania and the Soviet era. Today's stage of Lithuanian

[1] Order No V-792 of the Minister of Education, Science and Sport of the Republic of Lithuania of 6 June 2023 'On the Approval of the Description of the Procedure for the Establishment of the Lithuanian Research Infrastructures Roadmap and Participation in the Activities of International Research Infrastructures', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/11c9e08204a211eebc0bd16e3a4d3b97/asr.

RI development started after 2000, with the emergence of a systematic R&D policy paradigm. It has been given a major boost by the 2007–2014 programme for the development of science, study and business valleys, the 2014–2020 and 2021–2027 smart specialisation concepts and most importantly, the involvement in ESFRI activities and the integration into European and global RI networks in the second decade of the twenty-first century. Similarly, the first Lithuanian RI Roadmap was also prepared in 2011 and updated twice (in 2015 and 2020). The evolution of the Lithuanian RI Roadmap and the involvement in international RI is summarised in Annexes 2 and 3 to this Roadmap.

The assessment of the strengths, weaknesses, opportunities and threats of Lithuania's RI policy[2], has identified the following key challenges:

- inconsistency in RI policy;
- the gap between RI policy and RDI policy;
- lack of strategic approach to RI policy;
- lack of funding.

As a result, the following recommendations on the priorities and strategic directions of RI policy development have been formulated:

1. Lithuania's RI policy should have a stronger link with the broader R&D policy paradigm;
2. Lithuania's RI policy should maintain and develop cooperation with the EU and global RI ecosystems, global, regional and other international RIs, while maintaining a balance with the national RI;
3. Lithuania's RI ecosystem should not only focus on economic growth and competitiveness, but also on other national, EU and global public policy needs;
4. Lithuania's RI ecosystem should be developed in line with the envisaged directions of the European Green Deal;
5. RI policy should ensure the priorities of security, resilience and reliability;
6. A horizontal dimension of RI policy is needed – adequate legal framework, human resources, planning, data, monitoring, evaluation and funding.

The second part of the Roadmap, 'The Lithuanian RI Ecosystem and Directions of Development', summarises the situation of Lithuanian RI according to six thematic areas, following the ESFRI's division. In many of these areas, the Lithuanian RI ecosystem is still emerging. In most of the areas, representatives of the Lithuanian R&D ecosystem are looking for closer inter-institutional and interdisciplinary cooperation, and more targeted support for joining international R&D consortia and for membership; in some areas, gaps in the Lithuanian ecosystem can be found. The Lithuanian RI ecosystem reflects the smart specialisation priorities reasonably well, but it is not fully aligned with the broader green agenda and societal well-being needs to be identified in recent international and national strategic documents. Upgrading existing equipment and strengthening human resources is a pressing need for RI in all fields. They all need strengthening of digital infrastructure, data storage and processing capacities.

Following the Procedures for the Mapping of Lithuanian Research Infrastructures and Participation in International Research Infrastructures[3], the national and international linkages, the impact on scientific

[2] The Task Force analysed the previously developed Lithuanian RI Roadmaps, the related RI policy documents and the information for the forthcoming Roadmap applications, and interviewed representatives of currently operating RIs in Lithuania.
[3] See Footnote 1.

development and societal and economic progress, the gaps in the RI ecosystems, the needs, the connection with policy priorities and the need for investment are discussed for each of the RI areas.

In the area of Data, Computing and Digital RI, there are currently two national-level RIs – LitGrid-HPC and QUARTIC[4]. Their activities are still relatively strongly influenced by institutional priorities and lack the broader involvement of the national research community. Internationally, they are associated with the EGI, EuroHPC, GÉANT and TESTA infrastructures. Data, computing and digital RIs are indispensable for many areas of science and business, and have recently increased in importance for national security. It is noted that Lithuanian RI in this field lacks coordination and inter-institutional cooperation, and that greater interdisciplinarity is desirable. What RI in this field needs the most is funding, to ensure their operations and to upgrade their equipment, as well as strengthening their human resources. RIs in this area contribute directly to national and international digitisation and cyber security strategies, as well as to our country's smart specialisation priorities. Investments in upgrading equipment, fostering cooperation and expanding membership of international RI would help to fulfil these roles more effectively.

No national or international RIs exist so far in the field of energy. The Lithuanian research institutions in this field are characterised by lively cooperation, with VU, LEI, KTU, LUHS and CPTS playing a key role. Lithuanian scientists collaborate with international energy R&D institutions and organisations such as CERN, EERA, JET, NREL, EARTO, ESReDA and SNETP. The energy RIs have a huge development perspective related to the implementation of the Paris Agreement on climate change, the EU REPowerEU strategy, national energy independence strategies and smart specialisation priorities. On the other hand, Lithuania's so far episodic energy-related RI is characterised by a lack of mobilisation, low productivity, limited exploitation of international opportunities and a lack of resources to upgrade technologies. To promote involvement in international RI investments in the development of RIs in solar energy, biomass and geothermal energy, the commercialisation of research should be considered.

In the field of environmental RI, CLIMAGRO LT, BioDatCom Centre, FOREST 4.0 RIs are currently active. It should be noted that the picture of Lithuanian RIs in this field has changed significantly[5], reflecting the inconsistency and fragmentation of the development of RI. Due to the broad spectrum of environmental sciences, there is little cooperation between existing RIs, with a preference for international cooperation. The links between Lithuanian environmental RIs and the international RIs CETAF, DiSSCO, AnaEE-ERIC, ICOS ERIC, ILTER/eLTER RI, LifeWatch ERIC and EMPHASIS can be noted. Environmental RI underpins vital and relevant research in the fields of land, forests, water, air and biodiversity, and is closely linked to the political priorities of the circular economy, sustainability, climate change adaptation and biodiversity conservation. This RI contributes to the implementation of the European Green Deal and Lithuania's smart specialisation, and is well aligned with the directions of the State Progress Strategy 'Lithuania's Vision for the Future – Lithuania 2050'. It should be noted that Lithuania does not have any RI related to geosphere research. Among other gaps in the RI ecosystem in this area are the lack of open access to data and weak interdisciplinarity. As in other areas, environmental RI requires investment in upgrading and maintaining equipment, promoting cooperation and coordination, and supporting membership of international RIs.

[4] For explanations of abbreviations see the list on pages 7–11, and for a broader description of the Lithuanian RIs included in the Roadmap, see Part III of this document.
[5] See Annex 2 to the Roadmap.

In the area of Health and Food RI, there are national RIs for CossyBio, EBRAINS-LT, HBRC, PHENOPlant and RILAD. The supporting public institutions, NCI VU, VUH SK, LUHS, HLUHS KK, IMC, LAMMC, VMU, KUH, NRC, KTU, DNRIC and the research communities are working closely with each other and with private sector companies. National RIs in this field develop links with international RIs EMBL, EMBO/EMBC, INSTRUCT-ERIC, EBRAINS, BBMRI-ERIC, EMPHASIS and INFRAFRONTIER ERIC. Lithuanian researchers working in this field have reached world-class level and their activities directly contribute to the implementation of national, European and global health and well-being policies and smart specialisation. It is worth noting that there is a lack of cardiovascular and infectious diseases RI in Lithuania, and gaps in the ecosystem of this field in terms of data openness and interoperability, interdisciplinarity, practical application of research and RI management. The Health and Food RI faces needs for equipment renewal and research staff retention. The fields that require the greatest investment are data processing, telemedicine, animal welfare, translational research, phenotyping, genotyping, and personalised and precision medicine.

In the area of physical sciences and technology RI, national RIs currently include VU MAO, LDFK, ELI-LT, INNOCHEM and MNAC. Many of these RIs also support research in other domains, and they work with the international RIs CERN, ELI ERIC, WET, EUROPLANET, ESO and EuroNanoLab in addition to RIs in other domains. These RIs are involved in the implementation of the EU's Framework Programmes for Science such as European Horizon, they develop business innovations, disseminate scientific knowledge to the public and are fully in line with the priorities of the National Science Development Programme, Smart Specialisation. It should be mentioned that not all politically and economically significant fields, such the development of RI on semiconductor chips, are covered by Lithuania. Opportunities for membership of international RIs are also still under-exploited. In this area, RIs are relevant for increasing data processing and computing capacity, upgrading equipment, strengthening human resources and supporting international engagement.

In the field of humanities and social sciences, national RIs CLARIN-LT (formerly E-Lingua), ESS LT, GGP LT, LiDA, LIST, LTA TI / LFA IR, MEDem LT and SHARE Lietuva are now in operation or under development. Deep international integration with global networks of social research, social science and humanities data RIs, as well as vibrant inter-institutional and interdisciplinary collaboration, are characteristics of the socio-cultural RI ecosystem. These RIs are closely linked to the implementation of national socio-cultural policies and, less directly, to smart specialisation priorities. In this field, some RIs are developed primarily for national needs, filling research gaps left by international RIs (LIST). Given the continuous nature of socio-cultural research and long-term financing stability, policy and strategic vision are especially crucial for RIs in this area. The main needs are the further development of inter-institutional networking, increasing the availability of data, improving staff competencies and developing users, while increasing the impact of their research on public policy.

The third part of the Roadmap, 'Lithuanian RI', describes the selection of national RIs for the Roadmap. Following a call for applications for inclusion of RIs in the Roadmap, 22 applications were received. After a threshold assessment, 5 applications were rejected and 17 applications were referred for a comprehensive assessment. The comprehensive assessment was carried out by a panel of 25 experts from 14 countries worldwide. Six RIs were considered as having potential and eleven as mature. The Roadmap includes seven RIs that are associate or full members of international RIs, which have been recognised as established. A list of all 24 RIs, their maturity status and their participating institutions is available in Annex 4.

The descriptions of each RI by thematic area are also included in Part Three. The descriptions indicate the need and purpose of each RI covered in the Roadmap, describe their activities and services, and the international cooperation. At the end of the descriptions, general and web-based information on the RI is provided (e.g. URL links, RI representative and other participating institutions and status of RI according to various attributes).

INTRODUCTION

The Lithuanian Research Infrastructures Roadmap is an RI policy document that sets out long-term national and international RI policy directions, priorities, opportunities, prospects and insights for the future. The first Lithuanian RI Roadmap was published in 2011, and two more Roadmaps were produced, in 2015 and 2020. This Roadmap is therefore the fourth one – as infrastructures age, so do research Roadmaps, so they need to be updated continuously.

Preparations to update the Roadmap started a couple of years ago, with a major change in the legal framework governing the processes and actors involved in its creation. By redefining the concept of RIs, classifying them, allowing Lithuanian RIs to participate in international RI activities, monitoring the Roadmap's implementation and evaluating international RI members, the Lithuanian RI Roadmap has strengthened its political role. The importance of the Roadmap has been made clear: RI must be included in the Roadmap to be eligible for long-term public funding, but this requirement is not sufficient.

The preparation of the Roadmap essentially involved four stages:

1) updating the legal framework detailing the process of its preparation and approval;
2) preparation of an overview of the Lithuanian RI policy and ecosystem and mapping out of development directions;
3) selection of the RIs to be included in the Roadmap and preparation of their descriptions;
4) preparation, validation and approval of the Roadmap as a document.

The second and third phases were carried out in parallel.

A working group consisting of the administrative staff of the Research Council of Lithuania and members of its Expert Committee on Research and Higher Education Policy was used to update the legal framework.

An expert group made up of members of the Committee of Experts on Research and Higher Education Policy of the Research Council of Lithuania as well as researchers from research and higher education institutions in Lithuania and overseas participated in the second phase.

The group's findings were discussed at the meetings of the Research Council of Lithuania as well as with the academic community.

Before the second and third phase deployment, a public forum was held to debate the strategic directions for RI's continued development and the revision of the Lithuanian RI Roadmap. The discussion went over the history of the Roadmaps, talked about ESFRI's work and future plans, and briefed prospective Roadmap applicants on the evaluation process.

The process of choosing which RIs will be featured in the Roadmap began with a request for proposals. After a threshold assessment, 17 of the 22 applications that were received were submitted for a comprehensive assessment. An expert panel from Lithuania conducted the threshold assessment. A panel of 25 specialists, including researchers from 14 different nations, conducted the comprehensive assessment. All 17 RIs were assessed as eligible for inclusion in the Roadmap; 11 of them were rated mature and 6 were considered as having potential. The RIs have been arranged by the researchers into descriptions, which are presented in Part III of the Roadmap. The Roadmap includes those RIs that have joined worldwide RIs, which are acknowledged as established.

In the final stage, the Roadmap project was presented to the Commission for Research Infrastructures, which advises the Chairman of the Research Council of Lithuania on infrastructure issues. After the Commission's discussion, the project was declared open to the public with additions. Following adjustments, the draft Roadmap was resubmitted to the RI Commission after being debated in a public meeting with the business and academic communities, relevant research and study institutes, and other interested legal bodies. The draft Roadmap was submitted to the Council for Science, Technology and Innovation after it was approved. The Chairman of the Research Council of Lithuania ultimately gave their approval to the Roadmap.

Part I. History and Future Prospects of Research Infrastructures in Lithuania

1.1. Definition and Purpose of Research Infrastructures

Research infrastructures are an essential part of any science and research system. In a general sense, RI is understood as a set of interconnected structural elements that enable or support research. The Order of the Minister for Education, Science and Sport of 6 June 2023 defines RI as

> a set of tools, resources and related services used by the scientific community for research in relevant scientific fields. RI includes scientific equipment, research materials, knowledge resources, such as sets, collections, archives, and structured scientific information; information and communication technology-based infrastructures such as the grid network, computer equipment, software and communication tools and any other exceptional facilities that are essential for the conduct of top-level RDI activities[6].

This definition is an extension of the concept of RI set out in the Law on Science and Higher Education of the Republic of Lithuania, which corresponds to the concept of RI set out in the EU Regulation of 11 December 2013[7].

All RIs require three equally important components:

- research teams;
- material and information resources;
- services based on the expertise of the researchers, provided to the academic community, social partners or the general public.

Only RI with all three components can be considered sustainable and provide a solid basis for research and its dissemination.

---

[6] Order No V-792 of the Minister of Education, Science and Sport of the Republic of Lithuania of 6 June 2023 'On the Approval of the Description of the Procedure for the Establishment of the Lithuanian Research Infrastructures Roadmap and the Procedure for Participation in the Activities of the International Research Infrastructures', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/11c9e08204a211eebc0bd16e3a4d3b97/asr.

[7] Article 5(16)(1) of the Law on Science and Studies of the Republic of Lithuania No XI-242 dated 30 April 2009 (amended by No XIV-2585 of 25 April 2024), https://www.e-tar.lt/portal/legalAct.html?documentId=53896a50094611efbcbfb318996800a8.

In terms of form, RI can be:

- single-sited (localised);
- distributed (networked);
- digital (virtual).

Because of the demands of the natural, technological and agricultural sciences, the research community tends to be concentrated in research centres with physical facilities, therefore these sciences tend to be characterised by more concentrated (localised) infrastructures such as telescopes, particle accelerators and special purpose laboratories. Environmental and biomedical sciences are characterised by distributed (networked) infrastructures, such as research stations, biobanks, tissue repositories, bioinformatics data repositories and processing centres. Information plays a crucial role in the humanities and social sciences. It is crucial for researchers in these domains to gather, arrange, store and maintain as much and as many trustworthy sources and data as they can simply safely. As a result, these disciplines frequently have virtual (digital) infrastructures, such as digital libraries, data archives and subject search engines, that are accessible from each researcher's workstation via computer networks.

RIs are important because they

- strengthen research capacities, support scientific progress and innovation, and enable open, high-level science;
- provide the basis for scientific discovery;
- enhance the international competitiveness of research;
- improve cooperation between research teams and social partners;
- consolidate and optimise research capacities, avoiding fragmentation and duplication;
- promote synergies between RI funding instruments;
- have a significant social, cultural and economic impact.

In terms of scope and involvement in the international context, RI can be divided into three groups, which are also linked to the stages of RI development (Figure 1).

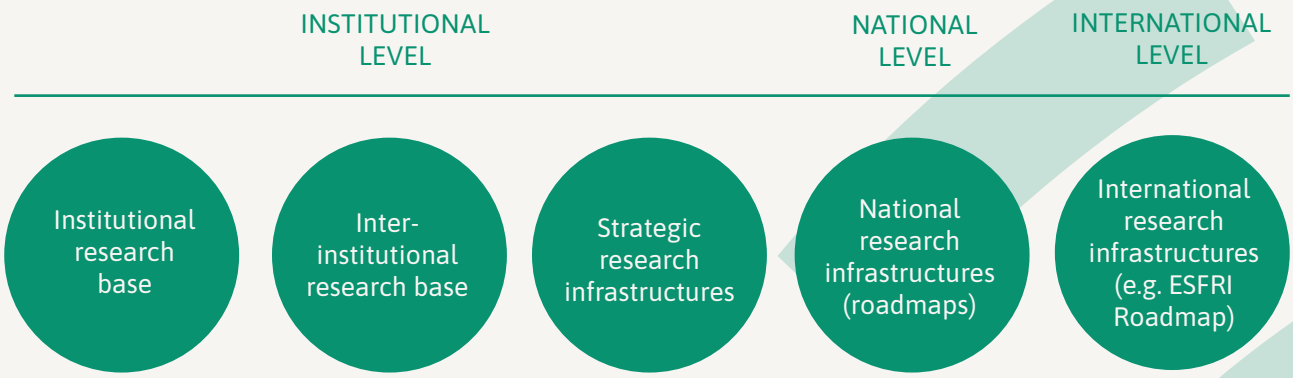


Figure 1: Categorisation of research infrastructures (based on the EFIS Centre's scheme

By enabling high-level open science according to the FAIR principles, RI can bring together strong and high-achieving groups of researchers, businesses, NGOs and other actors and mobilise their efforts to generate the scientific knowledge and innovation needed to address social and economic challenges.

One of the strategic science policy topics for which important national documents are developed is the growth of RI; one of these is the RI Roadmap. To ensure the most effective use of public funding, this paper addresses the primary demands for RI development and highlights the strategic priorities of national efforts while taking into account societal needs and scientific community capacities.

It is worth noting that the Roadmap does not attempt to cover all fields of science, but only those fields that require some form of research infrastructure for their existence and progress.

1.2. History and Development of RI

The history and policy of RI are closely linked to the emergence of 'big science', which emerged during the Cold War[8]. Since the Second World War, there has been a notable surge in investment in science and technology due to the ability of these professions to influence and shape geopolitics. Developed countries embarked on targeted large-scale research programmes to produce weapons and energy, develop transport systems and develop new materials for military and civilian applications. This made big science both a role model and a deterrent, while the link with nuclear energy, nuclear weapons and the US-Soviet rivalry gave it a geopolitical dimension.

In Europe, big science was developed not only in the context of the nuclear arms race but also because of the need to cooperate to ensure peace on the continent. The establishment in the 1950s of one of the most prominent and largest bodies of big science, the European Organisation for Nuclear Research (Conseil Européen pour la Recherche Nucléaire, CERN), was the first experience of large-scale scientific cooperation in post-war Europe. Other examples of big science in Europe include ESO, the European Synchrotron Radiation Facility (ESRF), the Institut Laue-Langevin and the European Free-Electron Laser Infrastructure (European XFEL).

With the rapid advances in technology and the expansion of knowledge creation, the last decades of the twentieth century saw a new reality: the cost of research and its infrastructures had reached astronomical levels in many strategic areas of science. Cross-border cooperation has therefore become not only an expression of goodwill between countries, but also a means to remain competitive in the global research landscape. Given the strategic value of modern scientific knowledge and its impact on the economic and political power of countries, it has been predicted that countries whose governments, for one reason or

[8] Katharina C. Cramer, Olof Hallonsten, Isabel K. Bolliger, Alexandra Griffiths,. Big Science and Research Infrastructures in Europe: History and current trends. In: Katharina C. Cramer and Olof Hallonsten (Eds.) Big Science and Research Infrastructures in Europe 2020, Cheltenham, UK: Edward Elgar p. 1–26, https://doi.org/10.4337/9781839100017.00007.

another, decide that research is too much of a luxury will in future become grey spots on the world map of science and innovation[9].

The EU's body of policy documents, reports and memoranda point to the twenty-first century as the era of research infrastructures. In recent decades, the EU has started to develop an RI policy to boost market competitiveness by promoting innovation, science and technology for prosperity, growth and sustainability. A major step forward in this area can be traced back to the Strasbourg Conference in 2000[10], where the scientific community, together with the European Commission agreed that RI is a key component of the Common European Research Area. The conference agreed that the development of RI should take place at national and international levels, combining the ideas of the research community with the actions of political and financial decision makers. To implement the ideas put forward at the Strasbourg Conference, the European Strategy Forum on Research Infrastructures (ESFRI) was formed by the European Commission in 2002 to coordinate a unified process for the development of EU RI infrastructures[11]. ESFRI's mission is to develop a coherent European RI policy strategy, to develop a common strategic approach, to harmonise national interests and to promote multilateral initiatives for the development and better use of RI in the EU and worldwide. The forum has developed a process for the development of RI, which covers the stages from idea generation to project implementation. This process has facilitated the alignment of the interests of different parties (states, organisations, academia).

In 2009, the Council of the EU adopted the European Research Infrastructure Consortium (ERIC) Regulation, which encourages new cross-border cooperation initiatives to develop and upgrade RI, and facilitates the implementation of projects under the ESFRI Roadmap. The ERIC has been granted legal personality recognised in all EU countries, with a flexible internal structure defined by the statutes of the consortium members. The ERIC members can be EU Member States, associated countries, non-associated third countries and intergovernmental organisations.

To align the instruments developed at the European level with the efforts of Member States, the ESFRI regularly produces the European RI Roadmap, a roadmap for the development of European RI that lays out long-term strategic orientations. Several EU Member States have begun to develop similar roadmaps after the European RI Roadmap's example. The coordinated and cooperative involvement of numerous nations in high-level RI activities presents Europe with new opportunities to compete in the global market for innovation and high-value research. The ESFRI Roadmap has previously been published in six editions, and work is now being done on the seventh. There are 22 candidate RI projects and 41 landmark European RIs in the most recent effective ESFRI Roadmap, which was released in 2021.

[9] National Development Institute. Analysis of public sector research and study infrastructure, Report II. Vilnius, 2007, p. 4, http://lms.lt/archyvas/files/active/0/II_ataskaita.pdf.
[10] Reflections on the role of research infrastructures in the European research area: highlights from the Research Infrastructures Conference, held in Strasbourg 18–20 September 2000. Edited by Campbell Warden, Luxembourg: Office for Official Publications of the European Communities; Lanham, Md., 2001.
[11] https://www.esfri.eu/.

The fact that RI continues to occupy a prominent place in EU science policy today is evidenced by the EU Council Resolution adopted during the Czech Presidency of the EU Council (second half of 2022), which states that RI is a priority of EU science policy[12]. The Brno Declaration, adopted in 2022, calls for support for the development of a global RI ecosystem[13]. The importance of RI in EU science policy is also reflected in the European Council's proposal to widen access to RI and to further develop the European RI ecosystem[14], and in the content of the conference held under the Belgian Presidency of the EU Council in 2024[15].

Cooperation between European countries on RI is driven not only by the EC. EIROforum, which brings together the eight largest European research organisations with extensive experience in basic research, scientific equipment arrays and research programme management, is one of the most important examples of such cooperation[16]. The goal of EIROforum is to ensure that European science realises its full potential by combining the resources, instruments and expertise of its member organisations. Lithuania is involved with two EIROforum members: CERN (associate member) and EMBL (full member). Members of the EIROforum engage in the creation of international RIs on an equal basis with the EU and its member nations. The GÉANT network is another illustration of multilevel European cooperation in the field of RI[17].

The Group of Senior Officials on Global Research Infrastructures (GSO on GRIs) and the OECD Global Science Forum address international RI development issues.

The Global RI Senior Officials Group was established in 2008 by the Science Ministers of the G7 group of countries to facilitate the international cooperation necessary for the planning and development of very large RIs[18]. Currently, 13 countries[19] and the European Commission are members of this group. The group's activities cover three main areas:

- defining the establishment of global RIs and key operational principles, and identifying best practices;
- exchanging information on modernisation, new construction and further integration plans for global RIs;
- making recommendations on the development and potential of the GRI landscape to the governments participating in the group.

[12] Roundtable at the National Library of Technology, 2022 m. vasario 3 d., žr. https://www.vyzkumne-infrastruktury.cz/wp-content/uploads/2022/02/CZ-EU-PRES-2022_Presentation.pdf.
[13] Brno Declaration on Fostering a Global Ecosystem of Research Infrastructures.
[14] Research infrastructures: Council adopts conclusions - Consilium.
[15] EMN Belgium Presidency High-Level Conference.
[16] https://www.eiroforum.org/.
[17] https://geant.org/.
[18] http://www.gsogri.org.
[19] Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, Mexico, South Africa, United Kingdom, United States.

One of the key outputs of the group is the GSO Framework, which helps RIs that aspire to global status to determine their level of compliance[20].

The OECD does not deal directly with RI development issues, but provides analytical information and policy recommendations relevant to RI development through the Global Science Forum. One of the most recent papers of this kind summarises best practices in the planning, management, financing, impact, data management and ecosystem development of very large research infrastructures (VLRIs)[21].

The development of RI is supported not only by European but also by global organisations. According to the UN, RI is essential to the advancement of innovation, science and sustainable development[22]. The SDGs and other UN policies make reference to resilient and inclusive RI. While SDG 4 on Quality Education emphasises the need for strong academic and research institutions, SDG 9 on Industry, Innovation and Infrastructure asks for the construction of a robust infrastructure to enable innovation and economic growth. In addition, UNESCO's objectives encourage the strengthening of RI by supporting the development of scientific capacities (especially in developing countries) and advocating policy frameworks that promote equitable access to research tools and technologies. The UN bodies such as the United Nations University (UNU) are working to foster worldwide research networks that facilitate knowledge sharing and collaboration to tackle major global challenges such as climate change, public health and poverty[23].

Through agencies such as the United Nations Environment Programme (UNEP) and the World Health Organization, the UN also funds sector-specific research infrastructures. By encouraging the growth of technology and innovation infrastructure in developing nations, the United Nations Conference on Trade and Development (UNCTAD) helps close the global research gap. By offering financial and technical assistance, the UN collaborates with commercial organisations and international organisations to bridge the gap in research infrastructure.

The international RI ecosystem includes global intergovernmental consortia projects such as the ITER International Fusion Reactor[24], the International Radio Telescope Laboratory (IRTL)[25], the International Space Station[26] and many others.

[20] http://www.gsogri.org/activities/the-gso-framework/.
[21] For instance, https://www.oecd.org/en/publications/very-large-research-infrastructures_2b93187f-en.html.
[22] https://sdgs.un.org/2030agenda.
[23] https://unu.edu/about/strategy.
[24] https://www.iter.org/.
[25] https://www.skao.int/en.
[26] https://www.nasa.gov/international-space-station/.

1.3. Lithuanian RI Roadmaps

The Roadmap is a strategic document for long-term RI policy, based on an analysis of Lithuanian and international RI, an assessment of existing and potential interactions between Lithuanian and international RI, and Lithuanian and European research priorities. The development of the Roadmap is one of the important processes of the country's science policy.

Legislation stipulates that the Roadmap is updated taking into account RI needs, long-term RI, and RDI policy priorities and changes in the research environment at least every four years[27]. To prevent funding disruptions, it makes sense to coordinate the review and updating process of the Roadmap with EU financing periods. For 2025 to be the next financial perspective, preparations are already being made for the new EU Financial Perspective. The Roadmap will be essential to Lithuanian RI's development.

The Research Council of Lithuania published the first Lithuanian RI Roadmap in 2011[28]. It can be seen as an attempt to better understand the then-existing potential of our country's RI and the promising directions for its development. The Roadmap applied European and global RI criteria to the national context and identified the first academic networks capable of matching international infrastructures. In 2011, the Roadmap presented 15 national RI projects pertinent to national R&D and identified international infrastructures Lithuanian researchers may benefit from participating in.

In 2012, the Minister of Education and Science of the Republic of Lithuania approved a description of the procedure for participation in international RI[29]. A description of the process for starting Lithuanian institutions' involvement in international RI was also approved by the Research Council of Lithuania in the same year[30]. Based on the latter, an RI Commission was established to assess the projects prepared by Lithuanian scientific institutions for membership of European RI, taking into consideration the needs of the Lithuanian scientific community, the readiness of the membership planners to participate in international RIs and the state's financial capacity. After examining the commission's conclusion, the Research Council of Lithuania decides whether to approve the membership plan of the proposed RI project and submits it to the Ministry of Education, Science and Sports of the Republic of Lithuania (MESS) together with the conclusions. Based on a proposal from the MESS, the Government of the Republic of Lithuania will make the final decision about Lithuanian institutions' involvement and membership in the international RI.

Lithuanian researchers have benefited from the opportunities offered by the first RI Roadmap for integration into international RIs. Language researchers from Vytautas Magnus University (VMU) joined CLARIN ERIC in 2014 after Lithuanian representatives of the ESS (ESS LT) joined the ESS ERIC consortium in 2013 in accordance with the 2011 Roadmap's recommendations and the connections with European RIs it identified.

[27] Order No V-792 of the Minister of Education, Science and Sport of the Republic of Lithuania of 6 June 2023 'On the Approval of the Description of the Procedures for the Establishment of the Lithuanian Research Infrastructures Roadmap and the Procedure for Participation in the Activities of the International Research Infrastructures', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/11c9e08204a211eebc0bd16e3a4d3b97/asr.

[28] https://lmt.lrv.lt/media/viesa/saugykla/2023/11/Xsc-xzLGsfA.pdf.

[29] Order No V-1068 of the Minister of Education and Science of the Republic of Lithuania of 2 July 2012 'On the Approval of the Description of the Procedure for Participation in International Research Infrastructures', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.430000.

[30] Resolutions No VII-127 of 17 December 2012 'On the Approval of the Description of the Procedure for the Initiation of Participation of Lithuanian Institutions in International Research Infrastructures' and No VII-130 'On the Approval of the Commission for Research Infrastructures' of the Research Council of Lithuania, https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.440340.

In 2014, the Research Council of Lithuania updated the Roadmap at the request of the Ministry of Education and Science[31]. The need to evaluate Lithuanian RI's progress and choose new infrastructures that might effectively represent the country's academic community served as the foundation for the second roadmap. Following an analysis of the proposals submitted by research and study institutions, an assessment of the need for RI at the national level and their prospects for integration into international consortia, the roadmap included seven new RI projects. Lithuania became a member of the European Molecular Biology Conference (EMBC) and the EMBO in 2016 and an Associate Member of CERN in 2018.

In 2019, a third draft of the Lithuanian RI Roadmap was introduced; however, the MESS has not approved this version[32]. At the meeting of the RI Commission on 30 January 2020, it was decided to 'postpone the approval of the list of research infrastructures proposed for inclusion in the Roadmap until the approval and evaluation of new national strategic documents allowing the evaluation of the list of RIs proposed to be included in the Roadmap'[33]. The draft Roadmap has been incorporated into the Lithuanian RI policy, even if the third iteration was not granted official status.

Annex 3 of this document shows how the list of facilities included in the Lithuanian RI Roadmaps has changed over time.

1.4. Context of the Lithuanian RI Policy

Higher education establishments and research centres from the First Republic of Lithuania and the Soviet era are where the Lithuanian RI had its beginning. The Lithuanian state lacked a comprehensive plan for scientific advancement during the first ten years after regaining its independence. As a result, Lithuania's research base was generally not renewed between 1990 and the beginning of the twenty-first century, and research was conducted primarily using resources from the Soviet era. The Research, Experimental Development and Innovation Policy, which was introduced in 2000 and aims to implement initiatives related to the creation, development and management of RDI infrastructure as a result of the country's political agenda and the EU integration process, has gradually begun to change the situation.

There are four periods of implementation of the Lithuanian RDI infrastructure policy:

- 2000–2006;
- 2007–2013;
- 2014–2020;
- since 2021.

[31] https://lmt.lrv.lt/media/viesa/saugykla/2023/11/PWNkIJIJItk.pdf.
[32] The list of Lithuanian research infrastructures included in the Roadmap is available in Annex 2, p. 36 of the Research Council of Lithuania 2019 report, https://lmt.lrv.lt/media/viesa/saugykla/2023/10/Er2HGr5qDck.pdf.
[33] Performance Report the Research Council of Lithuania 2019, https://lmt.lrv.lt/media/viesa/saugykla/2023/10/Er2HGr5qDck.pdf, p. 7.

The first period of implementation of the RDI Infrastructure Policy was the formative period of the Lithuanian RDI policy framework. As early as 2001, the Lithuanian Science and Technology White Paper[34], was published, which was prepared by the then Department of Science and Higher Education under the Ministry of Education and Science. It took stock of Lithuania's scientific capacities and discussed the political and economic context for their further development. The Resolution of the Seimas of the Republic of Lithuania of 12 November 2002 approved the State Long-term Development Strategy, which sets out the long-term priorities of the state's development and the directions of their implementation[35]. The first two of the three priorities – a knowledge-based society, a competitive economy and a secure society – can be considered the cornerstones of Lithuania's RDI policy, which has had a major impact on the requirement for the construction of both public and commercial RDI infrastructure.

The Concept for the Development of Science and Technology Parks (updated in 2013) was prepared and approved in 2003, giving impetus to the debate on the concentration of science and innovation infrastructure[36]. A science and technology park is a physical or virtual location for companies carrying out applied research and other innovative activities, with the main objective of improving the competitiveness of a region or area. There are currently seven science and technology parks in Lithuania.

In 2007, the Government of the Republic of Lithuania prepared a concept for the creation and development of integrated science, study and business centres (valleys). On the basis of this, the country's RDI policymakers, science and study institutions, science and technology parks, hospitals, business associations and enterprises made preparations and in 2008 the government approved programmes for five valleys[37]:

- Vilnius Medical and Pharmaceutical Valley Programme: initiated by VU with 30 partners, including five hospitals, four institutes, fifteen businesses, two associations and others. The programme aimed to create a valley in the areas of health sciences and pharmaceuticals high technology, innovative biomedical research, and information technologies in medicine and health information management technologies.
- Vilnius Technology Valley Programme: initiated by VU and VGTU including nine institutes, three science and technology parks, and four business and scientific associations. This programme aimed to develop the idea of a valley in the fields of applied physical sciences and technologies, life sciences (except medicine), biotechnology and information and communication technologies.
- Santaka Valley Programme: initiated by KTU, LUHS, (the former Kaunas Medical University), and the LEI, together with eight business enterprises and five business associations. The programme aimed to create a valley in Kaunas, which would carry out R&D and develop innovations in the fields of sustainable chemistry, mechatronics, energy, and information and communication technologies.

[34] Lithuanian Science and Technology White Paper. Vilnius: Justitia, 2021.
[35] Resolution No IX-1187 of the Seimas of the Republic of Lithuania of 12 November 2002 'On the National Long-Term Development Strategy', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.193888.
[36] Resolution No 963 of the Government of the Republic of Lithuania of 18 July 2003 'On Approval of the Concept of Development of Science and Technology Parks', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.215711/asr.
[37] A valley is a research, study and knowledge-intensive business potential concentrated in one territory, having a common or related infrastructure and purposefully contributing to the creation of a knowledge society and knowledge economy, and to the enhancement of the competitiveness of the Lithuanian economy (Concept of the Creation and Development of the Integrated Science, Study and Business Centres (Valleys), approved by the Government of the Republic of Lithuania by Resolution No 321 of 21 March 2007).

- The Nemunas Valley Programme: initiated by VMU (the former Aleksandras Stulginskis University), the Lithuanian Research Centre For Agriculture and Forestry (Lietuvos agrarinių ir miškų mokslų centras – LAMMC; the former Lithuanian Institute of Agriculture, Lithuanian Institute of Horticulture, and Lithuanian Institute of Forestry), the LUHS (the former Lithuanian Academy of Veterinary Medicine), in cooperation with five business enterprises, two business associations and others. The programme aimed to create a valley in Kaunas and Kaunas County, developing R&D in the fields of agrobiotechnology, bioenergy, forestry, food technology, and health and safety.
- Maritime Valley Programme: initiated by Klaipėda University (KU) together with four institutes, one science and technology park and eleven associated business structures. The programme plans the development of a valley operating in the fields of marine environment (natural resources and aquaculture, environmental protection and coastal management, and recreational resources and tourism) and marine technologies (maritime transport and ports, marine structures and technologies, marine mechatronics).

The valley programmes have aimed to develop specific areas into clusters of the knowledge economy, by pooling their dispersed scientific potential and by enabling science, studies and business to interact efficiently through a variety of means. This process was initiated by the then Prime Minister and the Knowledge Economy Forum. The Ministry of Education and Science and the then Ministry of Economy (from 2019, the Ministry of the Economy and Innovation (EIM)) were the coordinators of the initiative, to make the most efficient use of the 2007–2013 EU funds to mobilise and strengthen the country's strongest scientific potential, and to develop the existing and create new science-business linkages. The Ministries of Environment, Finance, Health, Agriculture and the Cabinet Office were also involved in the process.

The second period of RDI infrastructure implementation (2007–2013) saw an unprecedented level of EU investment, which gave the ministries responsible for the RDI policy the opportunity and responsibility to identify measures that could effectively strengthen the country's competitiveness through a more efficient translation of scientific knowledge into market products. The valley programmes established during this period encouraged the pooling of institutions and resources from related fields of science, which not only contributed to the efficiency of resource management, but also created the right preconditions for Lithuanian researchers to participate in European R&D consortia. However, it should also be noted that neither the preparation (2008) nor the adjustment (2014) of the valley programmes took into account the ESFRI Roadmap.

One of the main results of the 2007–2013 RDI infrastructure development initiatives was the creation of modern science centres in research and higher education institutions, which have been built on the basis of open-access RI. The Regulation on Open Access Centre (OAC) Management approved by the Order of the Minister of Education and Science of the Republic of Lithuania on 8 June 2010 establishes that an OAC is a specific RI facility deployed in an institution or network of institutions of science and higher education[38]. OAC and RDIs are closely linked and are formed on the basis of the same RDI infrastructure.

[38] Order No V-852 of the Minister of Education and Science of the Republic of Lithuania of 8 June 2010 'On Approval of the Regulation on the Management and Provision of Resources and Services of the Open Access Infrastructure for Scientific Research, Experimental (Social, Cultural) Development', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.375571/asr.

In the third period (2014–2020), the bulk of R&D funding has been directed towards smart specialisation priorities. Smart specialisation[39] is the EU's RI policy concept, which aims to achieve sustainable, innovation-driven economic growth by fostering collaboration between science and knowledge-intensive businesses with the highest potential. The essence of smart specialisation is to identify and focus on the areas where R&D has the greatest impact on the growth and competitiveness of a country's economy, by assessing the available and projected potential, and the most important national and global challenges and trends, thereby increasing the impact of R&D on the economy.

The 2016 Resolution of the Seimas of the Republic of Lithuania 'On the Approval of the Guidelines for the Change of the Lithuanian Science and Innovation Policy'[40]. is also significant for Lithuania's R&D policy. This document sets out the ambition to implement a transformation of Lithuania's research system focused on the development of an innovation-based economy and democracy.

Compared to the previous phases of the RDI infrastructure policy, the 2014–2020 period was characterised by a desire to use scientific knowledge more efficiently in the development of competitive products, and therefore most of the RDI system development measures were focused on smart specialisation activities – on the exploitation of the existing RDI potential – rather than on the increase of infrastructural capacities. This phase has not been without funding interruptions and a sharp decline in investment in RI[41]. In addition, the RI Roadmap launched in 2019 has not been completed.

In the fourth phase (2021–2024), the focus on RDI development in national policy was overshadowed by the global COVID-19 pandemic in 2020–2021 and the Russian aggression against Ukraine in 2022. As in the previous period, there was a lack of funding to support RI. However, there have been positive developments in the RI policy. In 2022, the Research Council of Lithuania programme was developed to fund RI membership of international organisations. Lithuania joined the ELI ERIC in 2021 and the EGI in 2023, together with three other EU countries. On 17 August 2022, the third Smart Specialisation Concept 2021–2027 was approved, aiming to strengthen research and innovation capacities, develop new technologies, and at the same time strengthen the country's competitiveness and position in global markets[42]. The Life Sciences Roadmap 2023 aims to increase the share of life sciences value added to 5% of total value added by 2030[43].

---

39 Resolution No 411 of the Government of the Republic of Lithuania of 30 April 2014 'On the Approval of the Programme for the Implementation of the Priority Research and Experimental Development and Innovation Development (Smart Specialisation) Priorities', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/78c68700d77c11e3b272e0e81c552d38;
Resolution No 760 of the Government of the Republic of Lithuania of 24 July 2019 'On Amendments to the Resolution of the Government of the Republic of Lithuania No 411 of 30 April 2014 On the Approval of the Programme for Implementation of the Priority Areas of Scientific Research and Experimental (Social, Cultural) Development and Development of Innovations (Smart Specialisation) and Their Priorities', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/c0ba9ee0b2a311e982dae1db4290b1a9;
Government Resolution No 835 of 17 August 2022 'On Approval of the Concept of Research and Experimental Development and Innovation (Smart Specialisation)', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/8b31ef00221011edb36fa1cf41a91fd9.

40 Resolution No XII-2654 of the Seimas of the Republic of Lithuania of 27 September 2016 'On the Approval of the Guidelines for the Change of Lithuanian Science and Innovation Policy', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/ee181db0861211e6a0f68fd135e6f40c.

41 Report on the Guidelines for the Development of Lithuanian RDI Infrastructures, p. 41, https://strata.gov.lt/wp-content/uploads/2024/02/2019-III-MTI-infrastrukturos-ataskaita.pdf.

42 Resolution No 835 of the Government of the Republic of Lithuania of 17 August 2022 'On the Approval of the Concept of Scientific Research and Experimental Development and Innovation (Smart Specialisation)', https://www.e-tar.lt/portal/lt/legalAct/9f349d40221011edb4cae1b158f98ea5.

43 Lietuvos gyvybės mokslų sektoriaus kelrodis.(The Lithuanian Roadmap for Life Sciences Sector).

During this period, the regulation of RI policy has also improved: Article 42 on RI has been added to the Law on Science and Higher Education, and the Minister of Education, Science and Sport has approved the description of the procedure for the establishment of the Lithuanian Research Infrastructures Roadmap and participation in international research infrastructures.

The guidelines for the national RDI policy in 2024 were updated by the description of the long-term development directions of the Science, Technology and Innovation Policy approved by the Seimas of the Republic of Lithuania[44]. The main objective of this is the development of the most promising directions of science, technology and innovation through an integrated multiannual strategic planning until 2050. It focuses on the development of the country's human capital (talent), the potential of science and entrepreneurship, the translation of the results of scientific research and innovation into the economy and social policies, the degree of their integrity and the competitive advantages that have been formed. The description recommends linking the science, technology and innovation strands to the State Progress Strategy 'Lithuania's Vision for the Future – Lithuania 2050'[45], as well as to the EU's RDI development programmes and support provided to EU policy areas.

1.5. Challenges and Insights for the Lithuanian RI Policy

The SWOT analysis of the Lithuanian RI policy (Table 1) shows that the following main challenges to the Lithuanian RI policy can be identified[46]:

- inconsistency in RI policy;
- the gap between RI policy and RDI policy;
- lack of strategic orientation of RI policy;
- lack of funding.

These strengths, weaknesses and opportunities identified in the SWOT analysis of Lithuania's RI policy provide the basis for recommendations on priorities for Lithuania's RI policy and strategic directions for RI development:

[44] The 'Description of the Long-term Development Directions of Lithuanian Science, Technology and Innovation Policy' approved by Resolution No XIV-2538 of the Seimas of the Republic of Lithuania of 11 April 2024, https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/ad54f302f80311ee97d7f4f65208a4ec.

[45] State Progress Strategy 'Lithuania's Vision for the Future – Lithuania 2050', https://e-seimas.lrs.lt/rs/lasupplement/TAD/a8b03ef0a55511ee8172b53a675305ab/a9c6aad0a5bf11ee8172b53a675305ab/format/ISO_PDF/.

[46] To summarise the challenges and opportunities of Lithuanian RI policy, the Working Group analysed the existing state regulation of RIs, the 2011, 2015 and 2020 Lithuanian RI Roadmaps and the information on the applications for the forthcoming Roadmap. The group interviewed representatives of the currently operating Lithuanian RIs and reviewed the most important R&D policy documents, such as the 2002, 2012 and 2023 Lithuanian RI Roadmaps. The research included state progress strategies, national progress plans, science development programmes, the concept of development of science and technology parks, the programme for the development of science, study and business valleys, and the concept of smart specialisation. The guidelines for the development of the science, technology and innovation policy and the inventory of development directions, and the funding programmes and instruments implementing the provisions of the RDI policy were also incorporated. It referred to the analytical literature on the development of the Lithuanian and international RIs, used the information on the international context gathered in the websites of the ESFRI Forum, the European Commission and other websites, and RI roadmaps of other European countries.

1. There should be a closer connection between the Lithuanian RI strategy and the larger RDI policy paradigm. As stated in the State Progress Strategy 'Lithuania's Vision for the Future – Lithuania 2050', the Concept of the General Plan of the Territory of the Republic of Lithuania, the National Security Strategy, the National Agendas implementing it, the National Progress Plan and other programming and planning documents for the long-term development of the state – the RI policy should be incorporated into the nation's overall RDI policy, which should then be connected to the general strategic directions of the state policy[47].
2. Our country's RI policy should maintain and develop cooperation with the EU and global RI ecosystems. The current Lithuanian RI regulation stipulates that the Lithuanian RI policy must be based on the ESFRI principles and standards, but to strike a balance, the national RI policy should take into account a broader context. This should encompass not only the ESFRI but also global, regional and other international RIs, while paying sufficient attention to the national RIs that meet the country's internal needs.
3. Lithuania's RI ecosystem should not only focus on economic growth and competitiveness, but also on other national, EU and global public policy needs. The RI ecosystem should be developed in a balanced way, taking into account the needs of societal well-being, sustainable development, the double transition (green and digitalisation), scientific progress and culture.
4. It is particularly important that Lithuania's RI ecosystem is developed in the context of the directions set out in the European Green Deal[48], which aims to avoid risks to society from environmental pollution, biodiversity loss and climate change, and to use the EU's natural capital and resources in an efficient and sustainable way. The Green Deal addresses the fundamental transformation of society, aims to neutralise the climate impact of energy and to build a clean, circular, energy and resource-efficient economy. Particular attention should be paid to preserving and restoring ecosystems and biodiversity, promoting responsible use of resources and building an environmentally friendly food system.
5. The RI policy should ensure the priorities of security, resilience and reliability. The provisions of the EU's General Data Protection Regulation are crucial for the use of health, biomedical and social science data[49]. The UN 2030 Agenda for Sustainable Development underlines the need for robust and secure infrastructure and highlights the importance of resilient RI in the pursuit of global innovation and sustainability. The UN Convention for the Protection of Critical Infrastructure in Armed Conflict and the provisions of the Hague Convention for the Protection of Cultural Property are relevant[50]. Consistent compliance with these international agreements also helps to protect scientific data and to ensure the survival of R&D in the face of cyber attacks.
6. All of these should be enabled by the horizontal dimension of the RI policy – appropriate legislation, human resources, planning, data, monitoring, evaluation and funding.

---

47 For a description of the Strategic Management Framework and a list of relevant strategic planning documents, see https://lrv.lt/lt/apie-vyriausybe/strateginis-valdymas/strateginio-valdymo-sistema-2/.

48 Communication from the Commission to the European Parliament, the European Council, the European Economic and Social Committee and the Committee of the Regions. A European Green Deal, https://commission.europa.eu/document/download/954374b5-2f9a-48f3-882c-07d9afddbabd_lt.

49 Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, https://eur-lex.europa.eu/legal-content/LT/TXT/?uri=celex%3A32016R0679.

50 UN Convention for the Protection of Critical Infrastructure in Time of Armed Conflict, https://www.un.org/counterterrorism/sites/www.un.org.counterterrorism/files/2225521_compendium_of_good_practice_web.pdf;
Second Protocol to the 1954 Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict, https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.159767.

Strengths	Weaknesses
• An appropriate legal framework for the development of RI; • Preparation of strategic documents necessary for the development of RI; • Setting part of the RI priorities in the national context; • Increasing competencies in the use of RI in scientific institutions; • Very good funding for some RIs; • Very good cooperation of some RIs with the business sector; • Some RIs attracting foreign researchers and specialists; • Business incubators, technology parks, spin-offs strengthening the need for RI; • Global links with international RI; • Active part of the RI ecosystem in the social sciences and humanities; • Growing investment in R&D and researcher potential.	• Fragmentation of the RI policy in terms of links to the context of the RDI policy and continuity; • Institutional and regional competition hampering RI cooperation; • Too weak science-business cooperation, low private investment; • Insufficient involvement of other sectors of government; • Lack of clear communication of the role of the Roadmap; • Too little focus on national RI without international counterparts; • Lack of coordination between RI actors; • Insufficient capacity to manage RI development projects; • No dedicated line for RI in the state budget; • Inability to attract foreign expertise and technology.
Opportunities	**Threats**
• Strengthening the scientific potential and competencies of researchers in international RI; • Strengthening links with foreign RI; • Emergence of new national needs that could stimulate the development of RI (such as national defence, health, energy); • Lithuania's leadership in certain RI areas; • Opportunities to increase funding from the EU and other funds; • Encouraging private capital participation in RI.	• Slow pace and poor administration of administrative processes for RI development; • Geopolitical threats that could redirect science funding flows towards defence needs; • Reduction of EU funding as Lithuania's prosperity rises and EU structural support is redirected towards less advanced EU Member States; • The absence of an RI component in the EU R&D funding policy; • Insufficient attention by decision makers to the importance of RI.

Table 1: SWOT Analysis of Lithuania's National RI Policy

Part II. Lithuania's RI Ecosystem and Development Directions

In addition to their relationships with research institutions, funders, customers and other members of the research ecosystem, the RI ecosystem is a network of interconnected actors, organisations and resources that make up RI.

The Order of the Minister of Education, Science and Sport of the Republic of Lithuania of 6 June 2023, which approved the RI Roadmap's description and establishment process, states that

- the RI ecosystem must be described by identifying the direction(s) of its development, its internal and international links, common needs and gaps, describing its activities in terms of scientific advancements and the ecosystem's impact on the economy and society;
- the ecosystem's connections to the long-term RI policy and smart specialisation priorities needs to be evaluated;
- potential investment directions should be suggested (the description also assumes that the Lithuanian RI Roadmap will be developed within the framework of the ESFRI Roadmap[51]).

In line with the 2021 version of the ESFRI Roadmap and the ESFRI decision on the revision of the name of the Social Sciences and Humanities RI area[52], an RI that has joined the Roadmap will be assigned to one of the six thematic areas:

- data, computing and digital research;
- energy;
- environment;
- health and food;
- physical sciences and engineering;
- social sciences and humanities.

As the following overview illustrates, the Lithuanian RI ecosystem is still in its early stages in several of these areas. Eight international RIs and seven national RIs have joined (Annex 3). There are gaps in the Lithuanian ecosystem in several areas, and many of the RI subject areas demand more focused support for membership and joining international RI consortia, as well as deeper inter-institutional and interdisciplinary cooperation. The smart specialisation priorities are quite well reflected in the Lithuanian RI ecosystem, but they are not entirely in line with the larger green agenda and the demands of societal well-being that have been noted in recent national and international policy papers. RI urgently needs to modernise its current equipment and enhance its human resources in every field. Strengthening digital infrastructure, data storage and processing capacities is essential for all sectors.

[51] LOrder No V-792 of the Minister of Education, Science and Sport of the Republic of Lithuania of 6 June 2023 'On the Approval of the Description of the Procedure for the Establishment of the Lithuanian Research Infrastructures Roadmap and the Procedure for Participation in the Activities of the International Research Infrastructures', https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/11c9e08204a211eebc0bd16e3a4d3b97/asr.

[52] See https://www.esfri.eu/latest-esfri-news/social-sciences-humanities-ssh-swg.

2.1. Data, Computing and Digital Research

COMPOSITION OF THE ECOSYSTEM AND TRENDS OF ITS DEVELOPMENT

There are two active RIs in Lithuania related to data, information and digital technologies: the Cyber Resilience RI (QUARTIC) and the Lithuanian High-Performance Computing Network (LitGrid-HPC). Participation in international infrastructures and initiatives (EGI, EuroHPC) is one of LitGrid-HPC's primary accomplishments. This has given Lithuanian HPC users access to the standard European grid user interface and made it possible for them to take advantage of European HPC resources. Based at KTU, QUARTIC plans to integrate data processing and information transfer into the TESTA and GÉANT ecosystems.

INTERNAL AND INTERNATIONAL LINKS WITHIN THE ECOSYSTEM

The cooperation between the existing Roadmap RIs is driven by the access to HPC resources provided by LitGrid-HPC. The latter RI focuses primarily on internal VU users and therefore has limited connections to other user groups. It is likely that with the connection to the EGI and the increase in computing capacity of this RI, both internal and international connections will become more intense. QUARTIC's communications are for the time being more dependent on the further development of the RI and its involvement in local and international cybersecurity projects.

ADVANCES IN SCIENCE WITHIN THE ECOSYSTEM. ECONOMIC AND SOCIETAL IMPACTS

LitGrid-HPC activities are essential to facilitate computation in a wide range of scientific fields, in particular astrophysics, biochemistry, biology, elementary particle physics, medicine and spectroscopy. LitGrid-HPC also helps to solve a wide range of engineering problems requiring high-performance computing. The RI is used by undergraduate and postgraduate students in their research, and is also used for learning parallel computing techniques.

QUARTIC can attract initiatives to develop and advance new technologies related to quantum computing solutions, and with them stimulate areas of the economy affected by high-tech developments. Societal impact is foreseen in the planning of robust post-quantum security systems.

GAPS IN THE ECOSYSTEM AND INTERNAL DEVELOPMENT NEEDS

The following gaps in the ecosystem should be noted:

- orientation towards technological and engineering problems, with a weaker development of interdisciplinary research involving the cultural and social aspects of society;
- lack of inter-institutional and interdisciplinary cooperation for the development of new scientific knowledge and international competitiveness;
- lack of coordination in promoting active participation in international RI activities.

The following internal needs for the development of the ecosystem should be highlighted:

- financial resources to develop and maintain state-of-the-art technological solutions (in particular QUARTIC);
- infrastructure maintenance, renewal and acquisition of new research equipment to promote open access and efficient use;
- strengthening and concentrating human resource capacity.

LINKS WITH LONG-TERM RI POLICY PRIORITIES

Digital RI initiatives support the development of a global knowledge society, ensure that technological advancements are logically incorporated into human contexts, and benefit both national and international society in addition to economic growth. The ecosystem's participants also partially align with the RI policy's horizontal priorities, which highlight the importance of information and communication technologies – particularly the advancement of machine learning and artificial intelligence (AI), as well as quantum and chip technologies – in advancing all facets of life and activity.

The existing ecosystem for RI is in line with the priorities detailed in the EU Cybersecurity Strategy (2020)[53], which sets out the need to ensure the security of the public in a globalised digital services environment. In addition, the activities of these RIs are in line with the EU's New Skills Agenda (2020)[54], which aims to improve the skills of workers to operate in the digital economy safely. It should be noted that both RIs are also in line with Lithuania's long-term priorities, as set out in the country's vision for the future 'Lithuania 2050', which outlines the correlation between digital security and sustainable development.

LINKS WITH SMART SPECIALISATION PRIORITIES

LitGrid-HPC directly addresses the Information and Communication Technologies priority of the Smart Specialisation priority on Big Data and Distributed Data, Multivariate Analysis, Processing and Deployment and Cyber Security. Indirectly, through research carried out on existing supercomputers, this RI also covers topics such as Molecular Technologies and Advanced Materials and Structures. QUARTIC is closely linked to the priority theme of Cyber Security, which, if not addressed, may make it difficult to address most of the other priorities.

[53] https://digital-strategy.ec.europa.eu/en/policies/cybersecurity-strategy.
[54] https://eaea.org/our-work/influencing-policy/monitoring-policies/new-skills-agenda-for-europe/.

POSSIBLE AREAS OF INVESTMENT

Priority areas for investment in RI for data, computing and digital research:

- Because they are ageing quickly, RIs in the data, computing and digital research ecosystem must systematically improve their research infrastructures to maintain their technological state-of-the-art.
- Investing in inter-institutional collaborative links is necessary to make more efficient use of research facilities.
- Membership fees of international RIs should be reimbursed

2.2. Energy

COMPOSITION OF THE ECOSYSTEM AND TRENDS OF ITS DEVELOPMENT

There are no national or international RIs in Lithuania that operate solely in the field of energy. Some RIs in the physical and engineering sciences, and environmental fields (e.g. REFRESH) are developing renewable energy, energy efficiency, energy storage and smart grid technologies in line with national priorities and the objectives of Europe's energy transformation. The Lithuanian research and study institutions supporting these RIs participate in global and European research organisations in the energy field, thus contributing to Lithuania's energy independence and sustainability goals.

INTERNAL AND INTERNATIONAL LINKS WITHIN THE ECOSYSTEM

The ecosystem of the energy RI includes VU, LEI, KTU, LUHS and the Centre for Physical and Technological Sciences (Nacionalinis Fizinių ir technologijos mokslų centras –FTSCPTS). Energy RDI activities include the development of technological and experimental facilities for the development of semiconductors and heterostructures, which are also essential for the involvement in the CERN CMS and LHCb experiments. Lithuania currently participates in the following international energy research organisations with an RI component:

- the European Energy Research Alliance (EERA)
- the European Council for Nuclear Research (CERN)
- the Joint European Torus (JET)
- the National Renewable Energy Laboratory (NREL)
- the European Association of Research and Technology Organisations (EARTO)
- the European Safety, Reliability and Data Association (ESReDA)
- the Sustainable Nuclear Energy Technology Platform (SNETP).

ADVANCES IN THE SCIENCE WITHIN THE ECOSYSTEM. ECONOMIC AND SOCIETAL IMPACTS

The impact of the energy RI relates to the Paris Agreement on climate change, the European Green Deal, the EU's energy transformation plan REPowerEU and the European Horizon Programme, which focuses on innovation in energy technologies, especially renewable energy sources. The strategic documents note that

the performance of the priorities of biomass energy production, solar energy, digital construction and bio-based raw materials is relatively weak. In the environmental field, Lithuania's main challenges are resource inefficiency and high-energy intensity. Now, there are significant strategic energy projects in our country, with the successful establishment and development of individual energy industries and the expansion of the RI ecosystem in the energy sector. The National Energy Strategy has stated that energy companies, businesses, and research and development institutions have accumulated outstanding competencies in the fields of solar energy, biomass, geothermal energy, liquefied natural gas and other areas, which need to be maintained, further developed and strengthened.

GAPS IN THE ECOSYSTEM AND INTERNAL DEVELOPMENT NEEDS

The following gaps in the ecosystem should be noted:

- insufficient use of RI in the RDI ecosystem to integrate renewables and energy storage solutions;
- insufficient pace of development of energy technologies that are compatible with the prevailing landscapes and ecosystems without compromising biodiversity;
- missed opportunities to engage in international high-budget RDI projects.

The following internal needs for the development of the ecosystem should be highlighted:

- lack of public and private investment in digital construction, solar energy and bio-based raw materials developments;
- insufficient funding for bioresources development, transport corridors, solar energy and digital construction projects;
- additional funding instruments needed to engage in new international RI.

LINKS WITH LONG-TERM RI POLICY PRIORITIES

Global RI policy priorities in the field of energy include accelerating the energy transition, improving energy security and achieving climate neutrality, with a focus on the goals of the Paris Agreement on climate change. Lithuania's energy innovation ecosystem comprises a community driven by a common purpose, with strong interconnections based on cooperation, trust and a desire to add value through the sharing of technologies and competencies. Lithuania's RI policy priorities in the field of energy are linked to the National Energy and Climate Action Plan 2021–2030, the National Energy Independence Strategy and the Law on Energy.

LINKS WITH SMART SPECIALISATION PRIORITIES

The Smart Specialisation Programme 2016–2020 identifies solar energy, molecular technologies and cloud computing as the priorities with the highest investment in prototypes. The 2021–2027 Smart Specialisation Framework anchors the energy themes with the priority New Manufacturing Processes, Materials and Technologies. This priority aims to ensure efficient and sustainable business development and the deployment of digital solutions and new technologies, and business–science cooperation in industry, thereby increasing productivity, added value and energy efficiency.

POSSIBLE AREAS OF INVESTMENT

Priority areas for investment in energy-related RI:

- strengthening the use of solar energy, biomass, geothermal energy for liquefied natural gas and other applications;
- commercialisation of the products developed for industrial production and export.

2.3. Environment

COMPOSITION OF THE ECOSYSTEM AND TRENDS OF ITS DEVELOPMENT

The environmental sector consists of atmospheric, biospheric, hydrosphere and geosphere sciences.

The RI of Environmental Sciences has so far been characterised by inconsistency. The documents prepared for the previous Roadmaps include five RTIs which, in their previous form, are not participating in the 2024 Roadmap.

The current Roadmap includes three RIs in the biosphere sciences. The first consortium, based on the Nemunas Valley includes LAMMC, LUHS and the VMU formed the Climate-smart Regenerative and Precision Agriculture Research Infrastructure (CLIMAGRO LT). CLIMAGRO LT aims to build on new knowledge through experimental research to ensure sustainable and resilient precision agriculture, agro-ecosystem stability and other ecosystem services now and in the future. The LAMMC Centre for Plant Genetics and Biotechnologies (AGBC) is partly involved in this RI and is an associate partner of the NBPPN International RI of the Nordic-Baltic Plant Phenotyping Network. The second research infrastructure formed by the Nature Research Centre, the Biodiversity and Geodiversity Data Centre (BioDatCom Centre), aims to digitise and provide open access to a wealth of biodiversity and geodiversity information. This will foster research and innovation, and provide the wider public with knowledge and insights relevant to informing decision-making and efforts to sustainably preserve biodiversity. The third RI, the FOREST 4.0 Centre of Excellence for Advanced Forestry, formed by VMU and LAMMC, develops digital technologies for future forestry and the forest-based bioeconomy. FOREST 4.0 aims to ensure the collection, curation and dissemination of forestry, ecology, carbon, biodiversity and other related data.

CLIMAGRO LT aims to collaborate with AnaEE-ERIC, the RI for Analysis and Experimentation on Ecosystems. The BioDatCom Centre is a member of the CETAF consortium of European taxonomic facilities, and FOREST 4.0 is actively involved in the ILTER/eLTER network of Integrated International/European Longitudinal Ecosystem Monitoring. It plans to continue its collaboration with EMPHASIS, the European Plant Phenotyping Infrastructure, and LifeWatch ERIC, the European Consortium of Biodiversity and Ecosystem Research Infrastructures. Furthermore, in the field of biospheric sciences, the Infrastructure for Metabolomic Ecology Research (INECOM), jointly developed by the NRC and the KU, covers the two Earth spheres of the biosphere and the hydrosphere, and collaborates with the European Marine Biological Resource Centre (EMBRC) in EMBRC ERIC.

Atmospheric sciences have been represented in previous roadmaps by the CPTS ACTRIS and the LAMMC-VU consortium Aerobiology Research Infrastructure (AEROINFRA). CPTS has the potential to fully integrate this RI into the ACTRIS ERIC network; AEROINFRA has the potential to collaborate with the international RI of the European Facility for Airborne Research (EUFAR) and the European Aerosol Research Lidar Network (EARLINET-ASOS).

In the field of hydrosphere, one RI is being developed – the Baltic Sea Division of the International Centre for Advanced Research on River-Sea Systems (NEMUNIUS-RI), which is a consortium of KU with NRC, VU and LEI. Its potential is to be realised in cooperation with the international RI LifeWatch ERIC.

INTERNAL AND INTERNATIONAL LINKS WITHIN THE ECOSYSTEM

The high degree of specialisation and the broad coverage of environmental sciences among the RIs that make up the environmental sciences ecosystem results in minimal collaboration between them, which is often limited to established institutional links. CLIMAGRO LT develops innovative land-use strategies and climate-smart agriculture systems, which are also based on AGBC plant genetics and biotechnological solutions for plant adaptation. FOREST 4.0 collects, compiles and evaluates forest ecosystem data and develops decision support systems that adapt forestry technologies to the realities of a changing climate. These three RI activities are interlinked, organically covering the land and forest sectors. NEMUNIUS-RI coordinates the use of research infrastructure and human resources for monitoring, analysing, modelling and assessing the socio-economic impacts of changes in the Nemunas River basin and the Baltic Sea. The BioDatCom Centre expands horizontal cooperation with environmental RI and stakeholder engagement, contributing to the conservation and responsible management of Lithuania's rich biodiversity and geodiversity for today and future generations.

ADVANCES IN THE SCIENCE WITHIN THE ECOSYSTEM. ECONOMIC AND SOCIETAL IMPACTS

The environmental sector's RI ecosystem comprises key research institutions that carry out basic and applied research on land, forests, water, air and biodiversity. These institutions have a strong impact on the development of a resource-efficient circular and climate-neutral bioeconomy. The aim is to preserve and enhance the country's natural capital and maintain a healthy and sustainable natural and living environment in the face of climate change and biodiversity loss.

GAPS IN THE ECOSYSTEM AND INTERNAL DEVELOPMENT NEEDS

The following gaps in the ecosystem should be noted:

- The development of RIs in the environment sector is inconsistent, and there is no continuity with the activities of the RIs included in the previous Roadmaps.
- There are no RIs representing surface and deep (geosphere) Earth sciences.
- RIs are mostly initiated by groups of researchers, resulting in a fragmented representation and development of environmental ecosystem sciences.
- The development of open access data centres is slow.
- There is little interdisciplinary research.

The following internal needs for the development of the ecosystem should be highlighted:

- maintaining existing RI infrastructure, timely modernisation and the acquisition of new research equipment to promote open access and efficient use;
- efficiency, consolidation and further development of human resource potential;
- strengthening inter-institutional and interdisciplinary inclusive cooperation to generate new scientific knowledge and innovation in the bioeconomy and to increase international competitiveness;
- coordinating activities to avoid duplication at the national level and to promote active participation in international RI activities.

LINKS WITH LONG-TERM RI POLICY PRIORITIES

The ecosystem of environmental RI reflects the current strands of the European Green Deal: preserving and restoring ecosystems and biodiversity, a fair, healthy and environmentally friendly food system and zero pollution, and a climate-neutral economy.

To achieve balanced and sustainable development of territories and coexistence with nature, the State Progress Strategy 'Lithuania's Vision for the Future – Lithuania 2050' outlines the challenges of climate change and the planet's ecosystem crisis, which are closely related to the ecosystem of environmental RI. Natural ecosystems will face the biggest problems in the future, and research infrastructures in the biosphere and hydrosphere are helping to find practical answers for the sustainable and balanced development of Lithuania's terrain. The National Progress Plan 2021–2030, the improvement of quality-of-life indicators, the impact of innovations on climate change and environmental quality, and the attainment of SDGs all depend on environmental sciences research.

LINKS WITH SMART SPECIALISATION PRIORITIES

- Health technology and biotechnology: The Advanced Applied Technologies for Personal and Public Health priority is being developed through pollen and spore allergen dispersion studies (AEROINFRA) and integrated studies of atmospheric pollution in the coastal (ACTRIS ERIC) and low-pollution regions of north-eastern Lithuania (FOREST 4.0). The theme Safe Food and Sustainable Agrobiodiversity includes studies on the use of genetic potential and climate change adaptation in agriculture (AGBC) and forests (FOREST 4.0). Precision and climate-smart agriculture (CLIMAGRO) and forestry (FOREST 4.0) are being developed.
- New production processes, materials and technologies: Under the Renewable Energy priority, RI is developing remote and ground-based methods for accounting woody biomass and adaptive forestry models. Works on the development of high added value products and the circular economy (FOREST 4.0) are being executed.
- Information and communication technologies: In the area of the priority AI, Big and Distributed Data, Heterogeneous Analysis, Processing and Deployment, data and metadata processing, standardisation and sharing systems are being developed through the IoT (BioDatCom Centre, FOREST 4.0).

POSSIBLE AREAS OF INVESTMENT

Priority areas for investment in environmental RI

- systematic renewal of research infrastructure to ensure its maintenance;
- financial incentives for inter-institutional cooperation to make more efficient use of research equipment and human capital;
- financial incentives for interdisciplinary bioeconomy research addressing climate change and biodiversity loss in an integrated way;
- reimbursement of membership fees for participation in international RIs

2.4. Health

COMPOSITION OF THE ECOSYSTEM AND TRENDS OF ITS DEVELOPMENT

According to ESFRI, the health and food sector includes RI aimed at improving human health, food and sustainable agriculture, based on advances in biomedicine, biotechnology, food safety and health knowledge. A network of interconnected RIs forms the foundation of this RI sector's ecosystem, facilitating developments in biomedicine, biotechnology, neuroscience, sustainable agriculture, translational research, animal welfare, and new materials and technologies that significantly enhance both individual and societal health.

The systematic development of biobanking resources for use in advanced biomedical research and personalised medicine is essential for the ecosystem. HBRC brings together the National Cancer Institute, Vilnius University, Vilnius University Hospital Santaros Klinikos (VUH SK), LUHS, Lithuanian University of Health Sciences Kauno Klinikos (HLUHS KK), IMC and KUH (new member) under a joint activity agreement. The RI carries out its activities in cooperation with public authorities responsible for data management, patient organisations and the private sector.

CossyBio was launched on the basis of the Saulėtekis, Santaros and Santaka valleys. In the field of molecular technologies, CossyBio has developed strong platforms to enable basic and applied research in medicine and biopharmaceuticals. Advanced tools for data storage, protein crystallisation and molecular analysis play an important role in the study of biological processes. CossyBio services are used by the VU, LUHS and NCI where this RI is located.

In pre-clinical research, RILAD focuses on building the infrastructure for precision gene therapy and disease modelling with high ethical and animal welfare standards. This infrastructure was pioneered by the University of Applied Sciences. RILAD collaborates with VU, LUHS and IMC. External partners at national level include NRC and NCI.

In the agricultural sector, PHENOPlant, a plant genetics and biotechnology-focused research infrastructure, has made significant progress in linking plant genotype and phenotype data. The RI is conducting research

on functional food. This RI brings together LAMMC and VMU. PHENOPlant makes an important contribution to the health and food sector by ensuring sustainability of production and high-quality raw materials for the production of functional foods.

The EBRAINS-LT Neuroscience Consortium brings together Lithuanian research universities working in the fields of medicine, social sciences, artificial intelligence (AI) and biomedical engineering, and includes hospital centres specialising in the treatment of neurological, psychiatric and neuro-oncological diseases. EBRAINS-LT is based on the European Brain Research Infrastructure (EBRAINS).

INTERNAL AND INTERNATIONAL LINKS WITHIN THE ECOSYSTEM

Adherence to the FAIR data management principles in the HBRC ensures data availability, enables researchers to develop new healthcare solutions, and enables international collaboration in the European Biobanking and Biomolecular Resources Research Infrastructure (BBMRI-ERIC). In the field of molecular technologies, CossyBio scientists have access to state-of-the-art technologies, and the strong infrastructure with its research capabilities encourages not only the maintenance but also the development of international collaborations. These include EMBL, the EMBC and EMBO, the Integrated Structured Biology Infrastructure (INSTRUCT-ERIC) and other organisations. The European Neuroscience Research Infrastructure in Lithuania (EBRAINS-LT), which is part of the European Brain Research Infrastructure (EBRAINS), carries out neuroinformatics and neuromodelling research applied in clinical practice. EBRAINS-LT's integration into European research networks, providing access to cutting-edge tools, expands research opportunities in neuroscience. RILAD contributes to cross-border collaboration in pre-clinical research through its participation in international networks for pre-clinical research (INFRAFRONTIER ERIC, European Research Infrastructure for Disease Modelling). PHENOPlant develops precision farming technologies to improve plant traits needed to develop resistant varieties in response to climate change, and conducts research on functional foods. The RI participates in the NPPN and the NBPPN, and aims to join the international infrastructure EMPHASIS.

ADVANCES IN THE SCIENCE WITHIN THE ECOSYSTEM. ECONOMIC AND SOCIETAL IMPACTS

As part of the Health and Food Ecosystem, RIs bring together research and study institutions that conduct research focused on improving human health, food and sustainable agriculture. The RIs in this group are characterised by high internationalisation and dissemination of information and publications. Through interdisciplinary and international collaboration, researchers are ranked among the world's top researchers. The RIs in the ecosystem all have a significant impact on precision medicine (CossyBio, HBRC, EBRAINS-LT), agriculture (PHENOPlant) and animal research (RILAD) through the use of information technology. In line with the highest ethical standards, sustainable science and the European Green Deal, the results of the research carried out by the ecosystem members are integrated into the global scientific context, clinical practice and everyday life. New tools and methods developed by the ecosystem-based RI contribute significantly to improving public health and well-being, and the economy.

GAPS IN THE ECOSYSTEM AND INTERNAL DEVELOPMENT NEEDS

The following gaps in the ecosystem should be noted:

- There are no RIs representing cardiovascular sciences, even though these diseases are the leading cause of death in Lithuania.
- There are no RIs on infectious diseases that are relevant in today's context.
- Cooperation and participation in national and international organisations, projects and research are not exploited.
- Development of open access to data is slow, and there is a lack of data interoperability between different laboratories and research centres.
- RI in this sector is entirely research-driven and therefore lacks interdisciplinarity and relevance to the needs of a broader user group, and poses challenges in terms of practical application, governance and finance.

RI in the health and food sector also faces challenges that may affect the further breakthrough and functioning of RI. In light of the challenges, the following key internal development needs of the ecosystem can be identified:

- For RI activities, there is a need for stable and long-term funding to maintain and upgrade the existing infrastructure (with the acquisition of specialised equipment where necessary), to attract and retain highly qualified researchers, and to secure participation in international organisations.
- The competencies of researchers needs to be upgraded through participation in training courses and conferences.
- There is a need for cooperation and participation in national and international organisations, and participation in the preparation and execution of major projects to generate innovation.

LINKS WITH LONG-TERM RI POLICY PRIORITIES

RI in the health and food ecosystem is in line with Lithuania's long-term RI policy priorities and the objectives of the European Research Area. RIs are sustainable, ensure the development of infrastructures that meet international standards, and have a long-term strategy for stable and efficient management. The ecosystem's members are involved in European and international networks, have equivalents in European and global RIs, ensure interdisciplinary research and use digital technology tools for data storage and processing. The RIs in this ecosystem support the European Green Deal strategy, which reduces potential negative environmental impacts and promotes sustainable science.

LINKS WITH SMART SPECIALISATION PRIORITIES

- RIs focused on personalised medicine, advances in diagnostics and treatment, and research into neurodegenerative diseases are developing the themes of the smart specialisation priority Health Technologies and Biotechnology – Molecular Technologies for Medicine and

Biopharmaceuticals, Advanced Applied Technologies for Personal and Public Health, and Advanced Medical Engineering for Early Diagnosis and Treatment. These RIs are also involved in the development of Advanced Applied Technologies for Personal and Public Health and in the development of Molecular Technologies for Medicine and Biopharmaceuticals. PHENOPlant RI conducts research on the topics of safe food and sustainable agrobiological resources.

- All Health and Food RIs deliver on the themes of the priority New Production Processes, Materials and Technologies, Energy Efficiency, Intelligence and Renewable Energy.
- For information and communication technologies, the Neuroscience RI (EBRAINS-LT) studies the brain and develops the priority themes AI, Big and Distributed Data, Heterogeneous Analysis, and Processing and Deployment under EBRAINS.

POSSIBLE AREAS OF INVESTMENT

Priority areas for investment in Health and Food RIs:

- data centre infrastructures that provide data security, fast processing and analysis, and can handle large volumes of data;
- clinical research centres and platforms for personalised and precision medicine research: laboratories, equipment, telemedicine solutions, collaboration between RIs;
- animal welfare infrastructures: animal housing, experimental equipment and monitoring systems;
- support for translational solutions to foster effective dissemination of research results and collaboration between RIs;
- technologies and equipment for plant phenotyping and genotyping studies, cooperation between RIs.

2.5. Physical Sciences and Engineering

COMPOSITION OF THE ECOSYSTEM AND TRENDS OF ITS DEVELOPMENT

The ESFRI Roadmap categorises infrastructures in the physical sciences and engineering as belonging to three scientific fields:

1) astronomy, astroparticle physics and space sciences;
2) nuclear and particle physics;
3) analytical physics.

The first category in Lithuania is represented by the Molėtai Astronomical Observatory (MAO) of Vilnius University, the second by the LDFK. The third, which covers laser physics, chemistry and materials science, is represented by the Laser RI. This includes the Centre for Innovative Chemistry (INNOCHEM), the Open Access Centre for Micro-, Nanotechnology and Analysis (MNAC) and the Research Infrastructure for Functional Materials for Sustainable Energy, Environment and Health (REFRESH).

Lithuania's physical sciences and engineering RI fulfils the main objectives set by the EC: they are open to both Lithuanian and global researchers, and there is no duplication of effort. However, the wider international cooperation efforts to design and develop sophisticated infrastructures capable of responding to global challenges are unfortunately insufficient.

INTERNAL AND INTERNATIONAL LINKS WITHIN THE ECOSYSTEM

The physical sciences and engineering RIs have different equipment unique to Lithuania and apply individual research methods, but there is some overlap in the objects of RI research. Internal ecosystem links are created by CERN-related research (e.g. MNAC is developing micro-structured gaseous electron detectors for recording ionising particles). Next-generation lasers are needed to reduce the size of the accelerators and are being developed by Laser RI. The VU MAO is advancing the fundamental knowledge needed to interpret CERN data.

The physical sciences and engineering ecosystem is also linked to other Lithuanian RI ecosystems. The ecosystem of data, computing and digital research is linked to the ecosystem of big data processing and the application of AI in research, which is of particular importance for the LDFK and VU MAO RIs. REFRESH, INNOCHEM and MNAC RIs contribute significantly to energy solutions. REFRESH's development of environmentally friendly materials is closely linked to the research on environmental RI. The Analytical Physics RI also carries out unique research related to the Health and Food RI ecosystem activities.

The biggest breakthrough in the physical and engineering sciences came in the field of particle physics in 2018 when the Lithuanian Particle Physics Consortium (LDFK) joined CERN as an Associate Member. The Laser RI – a national and international research infrastructure for high intensity and broad-wavelength ultrashort pulse lasers – is affiliated with the ELI ERIC – Extreme Light Infrastructure European Research Infrastructure Consortium, established by the Czech Republic, Hungary, Italy and Lithuania in 2021. The VU MAO has been a member of the WET Consortium since 1997, which brings together 29 observatories worldwide, and the Europlanet Telescope Network (EUROPLANET) from 2020, which brings together 17 European observatories with medium-sized telescopes. Lithuania's involvement in ESO, a network of 16 European countries with four 8.2 m telescopes and the world's largest 39 m telescope, would be a major breakthrough in astronomy. Since 2019, the Micro-, Nanotechnology and Analysis Open Access Centre (MNAC) has been a member of the EuroNanoLab network of nanotechnology laboratories, which consists of more than 40 state-of-the-art academic nanofabrication centres across Europe. REFRESH RI is affiliated to the Centre of Excellence for Sustainable Water Technologies and has access to 26 scientific facilities as part of its membership status, while membership of the NATO Defence Technology Accelerator DIANA Test Centre Network opens up access to materials testing at 180 scientific facilities across the NATO alliance.

International cooperation is particularly needed to support large-budget R&D projects, the development of large-scale innovative technologies and powerful new scientific instruments (e.g. high-power lasers, high-temperature superconducting magnets, energy recovery drive technologies, next-generation optics for telescopes and advanced detectors).

ADVANCES IN THE SCIENCE WITHIN THE ECOSYSTEM. ECONOMIC AND SOCIETAL IMPACTS

The state-of-the-art facilities and technologies brought together at the RI enable scientists to carry out ground-breaking research to improve our understanding of the universe, the relationship between the functionality and properties of materials and their atomic structure and dynamics, and the development of new materials with new properties. The Lithuanian RIs in the physical sciences and engineering make a significant contribution to the objectives of the Science Development Programme 2021–2030 by creating an attractive research and study environment, and increasing student participation in R&D activities. RIs actively contribute to the advancement of science through national, EC Horizon 2020 and Horizon Europe programmes and cross-border research projects. The VU MAO, LDFK and Laser RIs are particularly active in disseminating scientific knowledge to the public by hosting guided tours and regular events such as the European Researchers' Night, the International Hadron Therapy Masterclass and the World Quantum Day.

In the physical sciences and engineering, the RI works closely with science-intensive companies, promoting the creation of new start-ups by presenting new and improved technologies and prototype devices. REFRESH, Laser RI, MNAC and INNOCHEM RIs are the most active in this field. However, RIs in this field should do more to inform business and industry about the opportunities that these sciences offer for product development and the development of advanced technologies. In addition, RIs in this field actively offer training programmes, seminars and summer schools to improve the skills and knowledge of scientists and students. Examples include the VU MAO, which has been organising regular international summer schools on topical astronomy topics for 25 years, and MNAC, which has been organising PhD students' schools on advanced materials and technologies for 26 years.

GAPS IN THE ECOSYSTEM AND INTERNAL DEVELOPMENT NEEDS

The following gaps in the ecosystem should be noted:

- A semiconductor chip RI could complement the ecosystem.
- The opportunities offered by international RIs are not sufficiently exploited.
- There are missed opportunities for cooperation in support of international high-budget R&D projects.
- It would be appropriate for all RIs in this field to organise regular information training sessions to introduce the state-of-the-art infrastructures available and to attract new users from Lithuania and abroad.

The following internal needs for the development of the ecosystem should be highlighted:

- advanced data analysis, management and storage capabilities for comprehensive data analysis and open science;
- expanding high-performance digital resources and ensuring data archiving to facilitate access, sharing and reuse of data;
- continuous renewal of RI facilities, increasing the base funding and the number of funded PhDs.

LINKS WITH LONG-TERM RI POLICY PRIORITIES

Lithuania's physical sciences and engineering RI makes a strong contribution to all the objectives of the Science Development Programme 2022–2030. The problems of low base funding and the number of funded PhDs identified in the programme limit the activities of RI to some extent, but the problems of a good R&D environment and student involvement in R&D activities are being addressed successfully. The capacity to raise the profile of Lithuanian science at home and abroad should be strengthened, both within RI itself and in the Lithuanian science ecosystem.

LINKS WITH SMART SPECIALISATION PRIORITIES

- New manufacturing processes, materials and technologies: In the physical and engineering sciences RI ecosystem, the Laser RI, INNOCHEM, MNAC and REFRESH RIs have made the most significant achievements in the themes of Photonics and Laser Technologies, Advanced Materials Technologies and Energy Efficiency.
- Information and communication technologies: The basic research-oriented RIs of LDFK and the VU MAO actively contribute to the development and deployment of AI, big data and distributed data processing technologies.

POSSIBLE AREAS OF INVESTMENT

Priority areas for investment in physical sciences and engineering RI:

- Continuous renewal and upgrading of the equipment used in the infrastructures is essential to enable the RI to continue to deliver high-quality research results.
- It is important to ensure sufficient investment in digital infrastructure in the physical and engineering sciences, which is essential to increase storage and computing capacity.
- Coordination of database systems across disciplines is needed, and easier access to physical collections.
- Basic RI funding should be allocated and there should be an increase in the number of funded PhDs.
- More flexible funding is needed for mergers and access to international RI.

The development of new national infrastructures will be driven by the growth in scientific potential. Scientific progress is increasingly dependent on the capacity of research facilities, and it is therefore essential to make the most of the opportunities offered by international RI.

2.6. Humanities and Social Sciences (HSS)

COMPOSITION OF THE ECOSYSTEM AND TRENDS OF ITS DEVELOPMENT

The HSS RI ecosystem consists of the following:

- language archives and tools (LTA TI/LFA IR);
- long-term international comparative studies (ESS LT, GGP LT, SHARE Lithuania, MEDem LT);
- data archives that manage and make data publicly available (CLARIN-LT LiDA);
- national longitudinal studies (LIST), linking RI with the State Data Agency and STRATA.

Over the past ten years, various research institutions have worked with international RI networks to establish the HSS RI in Lithuania. Due to the need for more effective infrastructure development at the national level, RI has recently been strengthened by both national and international cooperation. With the formation of inter-institutional consortia, the extension of their international relations and the development of scientific resources, the majority of infrastructures now transcend the borders of individual universities and research institutes.

Since survey and sampling techniques from twenty or even ten years ago no longer yield trustworthy HSS research results, current societies must innovate their methodology and research techniques to address the global complex issues they face. To provide more efficient control, monitoring and quality assessment, RI creates and distributes innovations throughout Lithuania that span the many stages of research.

Another significant advancement in HSS RI is open science, which makes it possible to concentrate more on the socio-economic effects of research, collaborate with businesses and disseminate scientific knowledge in new ways that involve different social groups.

INTERNAL AND INTERNATIONAL LINKS WITHIN THE ECOSYSTEM I

The HSS RI brings together a wide range of scientific disciplines and interest groups, and it promotes interdisciplinary and transdisciplinary research. The various disciplines of HSS – such as anthropology, history, communication, linguistics, political science, psychology, sociology, management and economics – are brought together by the RI in networks of researchers. This collaboration allows for a better knowledge and understanding of multidimensional social and cultural phenomena.

Long-term international comparative research implies extensive involvement in international networks of research institutions, not only for the implementation and management of research, but also for the training of researchers capable of working with RI data. International RI networks strengthen the European Research Area. This is particularly important in addressing common socio-cultural challenges that are not only of national but also of pan-European importance.

ADVANCES IN THE SCIENCE WITHIN THE ECOSYSTEM. ECONOMIC AND SOCIETAL IMPACTS

The HSS RIs complement each other by broadening the range of topics of relevance to Lithuania and other countries, and by promoting cooperation between different scientific disciplines. Examples of such constructive networking are the European SERISS[55] and the Social Sciences and Humanities Open Cloud (SSHOC)[56] projects funded by the EC's Horizon 2020 programme. The SERISS project coordinated the activities of five RIs – ESS, SHARE, CESSDA, GGP and EVS (European Virtual Scientific Infrastructure) – and addressed issues related to survey design and data collection, data management and data processing. The project has improved the European social science infrastructure and its role in addressing major societal challenges and in shaping data-driven European policies. The SSHOC project has transformed the design of data in the social sciences and humanities, moving away from data sets that were provided on a discipline-by-discipline basis to an integrated network of data across different infrastructures.

The quality of the research carried out and the accessibility of the results to the national and international academic community, public institutions and private companies are important for scientific progress and innovation. The socio-economic impact of RI is linked to the communication and dissemination of research results across different sectors (public administration, civil society, business).

The new GGP LT and LIST projects included in this Roadmap will implement an innovative longitudinal panel survey in Lithuania based on probability sampling, a combination of survey methods and a respondent incentive system. Such surveys, which have been carried out in other countries for years (such as the GESIS Panel (Leibniz Institute for the Social Sciences), LISS Panel and the Rand American Life Panel), will allow researchers to study not only the current attitudes and behaviour of the population, but also their evolution and changes.

GAPS IN THE ECOSYSTEM AND INTERNAL DEVELOPMENT NEEDS

The following gaps in the ecosystem should be noted:

- lack of a strategic approach;
- lack of long-term funding;
- unsustainable infrastructure;
- lack of human resources.

[55] https://seriss.eu/.
[56] https://sshopencloud.eu/.

The following internal needs for the development of the ecosystem should be highlighted:

- As HSS RIs are organised in consortia, it is important to ensure continuous inter-institutional networking, which requires human resources to develop.
- Securing long-term finance is crucial. The continuation of long-term research is crucial since they comprise a significant portion of the HSS RI ecosystem and must be duplicated on a regular basis.
- Researchers' competencies need to be developed to carry out high-quality research.
- The capacity of the public sector, business and non-governmental organisations (NGOs) needs to be built to use HSS RI data.

LINKS WITH LONG-TERM RI POLICY PRIORITIES

HSS RIs, both national and European, are crucial for the advancement of the sciences as well as for the advancement of the economy, society and cultural legacy. HSS RI serves as the foundation for data-driven policymaking and for disseminating research-based information on significant social, cultural and political topics to public authorities and the general public. Additionally, these RIs support the growth of a knowledge economy, in which information and knowledge are the main forces behind economic activity.

LINKS WITH SMART SPECIALISATION PRIORITIES

Lithuania's HSS RI ecosystem has the potential to contribute to smart specialisation priorities in the areas of health technologies and biotechnologies, new production processes, materials and technologies, and information and communication technologies. This is thanks to its inter- and transdisciplinary research providing insights into the social, economic, ethical and cultural dimensions of innovation and technological development. This helps to ensure that the results of technological and scientific progress are not only technically efficient, but also socially responsible, ethical and beneficial to society as a whole.

Smart specialisation priorities have evolved. In 2014, one of the six smart specialisation axes adopted by the government was the axis Inclusive and Creative Society. It can be assumed that this axis is directly linked to the HSS RI. The Government Resolution stated that this axis was chosen to respond to social challenges and future trends such as:

- declining demographics;
- uneven regional development, poverty, undeclared work and insufficient social cohesion;
- skills gaps with labour market needs, insufficient talent and creative potential;
- lack of innovation and effective public sector management.

This is echoed in the 2019 Government Decrees. The situation has changed with the 2022 update of the smart specialisation concept. Among the remaining three RDI priorities – Health Technologies and Biotechnologies, New Production Processes, Materials and Technologies, and Information and Communication Technologies – there is no longer a strand directly related to the HSS theme. On the positive side, this choice could be interpreted as an attempt to integrate HSS into interdisciplinary research.

- Health technology and biotechnology: Topics of relevance to the HSS RI are public health research, ethical and social aspects of health technology and biotechnology development, patient and consumer experience research, and e-health solutions development. HSS RIs such as SHARE and GGP are relevant in this area.
- New manufacturing processes, materials and technologies: Topics of relevance for HSS RIs include impact analysis of technological change, work ethics and social responsibility, research on the application of innovation, and cultural and social innovation trends. HSS knowledge in this area is complemented by ESS and LIST.
- Information and Communication Technologies: Topics of interest for HSS in terms of RIs are social networks and digital society, data privacy and ethics research, digital democracy and civic engagement, and cultural and social dimensions of digital technologies. HSS's expertise in this area is complemented by LiDA, MEDem, ESS and LIST.

POSSIBLE AREAS OF INVESTMENT

Priority areas for investment in the HSS RI:

- Global, regional and national developments require continuous investment in the renewal and development of HSS RI infrastructures, both in terms of mandatory annual participation fees in international RIs and in terms of the necessary updating of methodologies and approaches.
- Investment in the networking of the RI ecosystem is important to enhance the efficiency of HSS RI interactions.
- To increase the impact of HSS RI, it is necessary to invest in the availability of data (open data) and the capacity of the different user groups to use the data.
- To enhance the impact of HSS RI on public policy, it is important to mobilise interdisciplinary and transdisciplinary groups to develop recommendations for public policy.

Part III. Lithuania's RI

3.1. Selection of National RIs for the Roadmap

Preparations for the Roadmap's establishment started after the Ministry of Education, Science, and Sport approved a significantly revised procedure for its creation ('Rules' approved by the Minister of Education, Science and Sport of the Republic of Lithuania by Order No V-792 of 6 June 2023 'On the Approval of the Description of the Procedure for Establishment of the Roadmap of Research Infrastructures in Lithuania and for the Approval of the Procedure for the Participation in the Activities of the International Research Infrastructures'). Specifically, a two-tier system was chosen to review proposals for inclusion in the Roadmap, with a threshold evaluation serving as the first tier and a second tier comprising a comprehensive assessment of applications. The criteria for the threshold and comprehensive assessment have been decided with the help of experts and the application, threshold and comprehensive assessment forms have been developed. The whole evaluation process was governed by Regulation No V-281 on the Development and Approval of the Lithuanian Research Infrastructure Roadmap. This was approved by the Order of the Chairman of the Lithuanian Research Council of 26 June 2024 'On the Approval of the Regulation on the Development and Approval of the Lithuanian Research Infrastructure Roadmap'. It contains in its annexes the forms for the threshold and detailed (comprehensive assessment) evaluation as well as the values of the detailed evaluation scores for the evaluation criteria.

The call for applications for the inclusion of RI in the Roadmap was published in mid-June 2024 and applications were open until mid-August. A total of 22 applications were received.

3.1.1. Threshold Assessment

Applications were evaluated according to three evaluation criteria:

- the request and impact of the RI;
- the readiness and maturity of the RI;
- the feasibility of the RI (management).

The evaluation panel consisted of eight experts working in Lithuania. Each application was evaluated individually by two members of the panel. A decision was taken at a joint meeting of the panel after discussing the individual assessments. If the panel decided that at least one of the evaluation criteria was not satisfactory, the application was not submitted for full (comprehensive assessment) evaluation. There were five such applications, only one of which was rated insufficient under the RI's need and impact criterion. The most frequent negative scores were given for the RI's readiness and maturity criterion and the RI's feasibility/management criterion – four times. Seventeen applications were referred to experts for comprehensive assessment.

3.1.2. Comprehensive Assessment

The applications were evaluated against the same three evaluation criteria, but with three sub-criteria per criterion:

- Request and impact of the RI need and impact:
  - request and goals of the RI;
  - alignment of the RI with national and European research policy;
  - expected impact on science, technology and socio-economic development.
- Readiness and maturity of the RI
  - experience and competence of the institution (consortium);
  - competences of researchers, results of scientific activities and international competitiveness;
  - available equipment and technical infrastructure.
- Feasibility of the RI (management)::
  - reasonability and appropriateness of strategic plan;
  - validity of the financial plan;
  - relations with business and social partners.

The jury consisted of 25 experts from 14 countries around the world – Ireland, Austria, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Poland, the Netherlands, Portugal, Switzerland and the United Arab Emirates. Each application was evaluated individually by two or three members of the expert panel.

The experts' scores were assigned on the basis of a matrix of scores per evaluation criteria for the comprehensive assessment. It should be underlined that none of the RIs included in the comprehensive assessment were found to be ineligible for inclusion in the Roadmap.

Potential RIs were those that scored below nine on all three criteria (Figure 2). Those RIs with a score of nine or more and a score of three or more on all three criteria were considered mature.

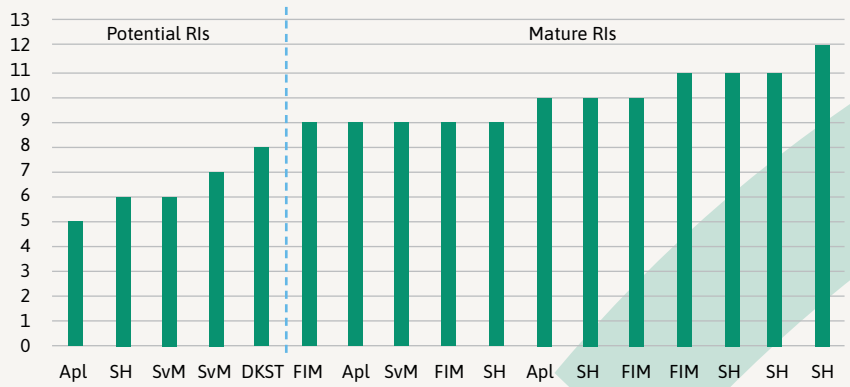


Figure 2. Results of the comprehensive assessment
(See 'Abbreviations' section for definitions.)

Of the 17 RIs assessed during the comprehensive assessment, 5 were considered potential and 12 were considered mature.

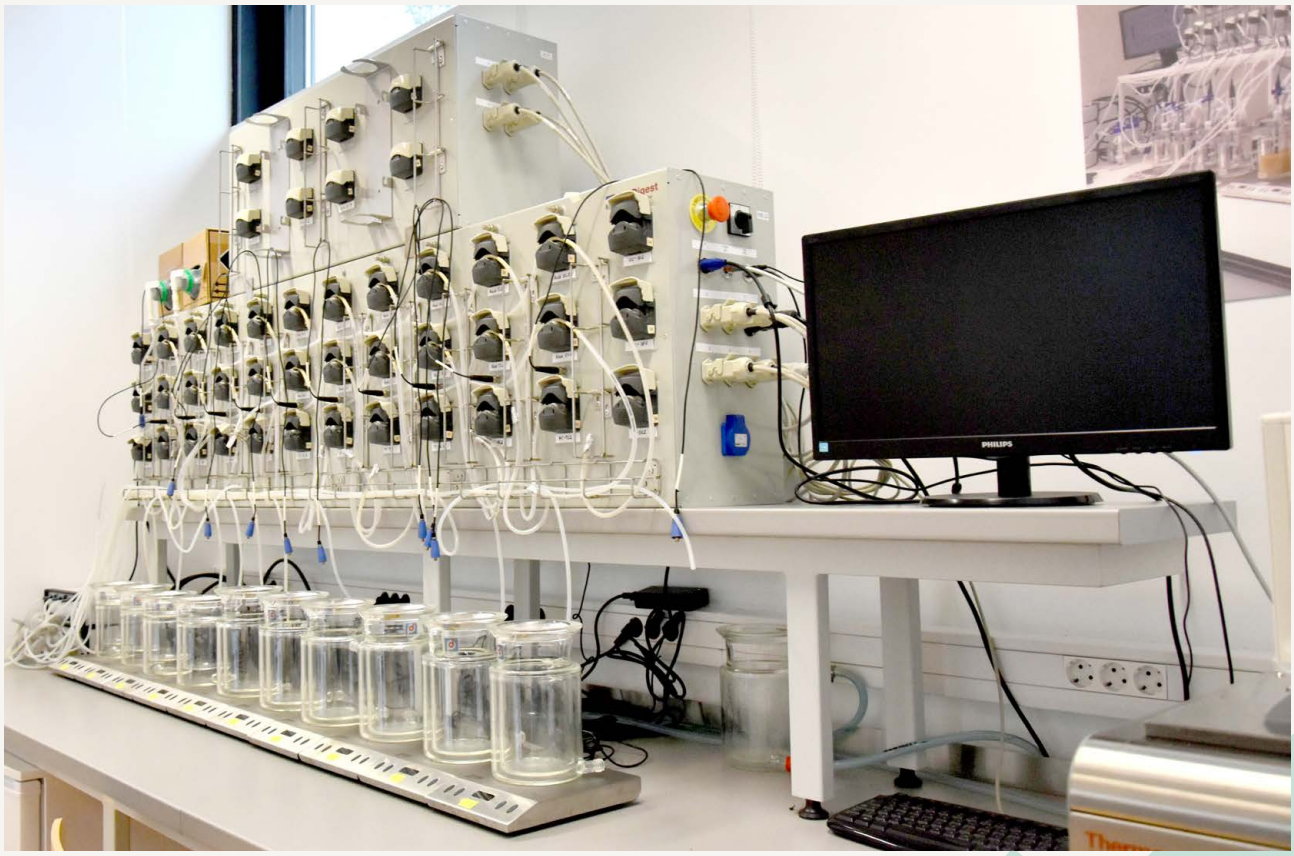
3.2. Data, Computing and Digital Research

3.2.1. Cyber Resilience Research Infrastructure (QUARTIC)

The Cyber Resilience Research Infrastructure (QUARTIC) aims to strengthen security by developing solutions that are resilient to quantum attacks and by ensuring that existing systems are protected against future threats. The infrastructure connects with international research networks to collaborate on the development of quantum security standards and techniques. QUARTIC includes training for cybersecurity professionals to promote the development of their competencies in quantum technologies. In addition, QUARTIC contributes to increasing the cyber resilience of society and training professionals.

THE NEED FOR AND PURPOSE OF THE RI

The need for RI stems from the requirement to develop advanced technologies to address critical scientific and societal challenges. QUARTIC aims to address the cybersecurity challenges posed by post-quantum threats. Modern encryption methods may become ineffective with the advent of quantum



Public use image. Source – Kaunas University of Technology.

technologies, making it necessary to develop new resilience solutions. The purpose of the RI is to ensure high-quality research, fostering innovation and technological development in a wide range of fields. Such infrastructures not only enhance the international competitiveness of scientific results, but also contribute to sustainable economic and social development.

ACTIVITIES AND SERVICES OF THE RI

RI provides advanced technological services that enable researchers and scientists to carry out high-level research in a wide range of fields. It provides access to specialised equipment, research data and expertise needed to develop innovative solutions. In cooperation with global research infrastructures, QUARTIC's primary operations include developing solutions that are resistant to quantum attacks, identifying secure data transmission techniques, conducting cyber-risk assessments and creating standards. Cyber security experts are also trained in quantum technologies as part of the infrastructure, with an emphasis on cybercrime and defences against quantum threats.

INTERNATIONAL COOPERATION OF THE RI

The RI is actively involved in international projects to strengthen scientific cooperation and promote innovation on a global scale. It connects with other international infrastructures, such as GÉANT, to exchange knowledge and best practices in cybersecurity and other areas. This cooperation allows RI to seize shared technological opportunities to accelerate research progress. QUARTIC seeks to actively collaborate with international partners such as the National Cyber Security Centre, the TESTA network, the European Quantum Communication Infrastructure (EuroQCI) and the European Quantum Technology Flagship. These partners will enable QUARTIC to expand its technologies and applications internationally, ensuring that the quantum resilience technologies they develop are integrated into the European research and cybersecurity ecosystem.

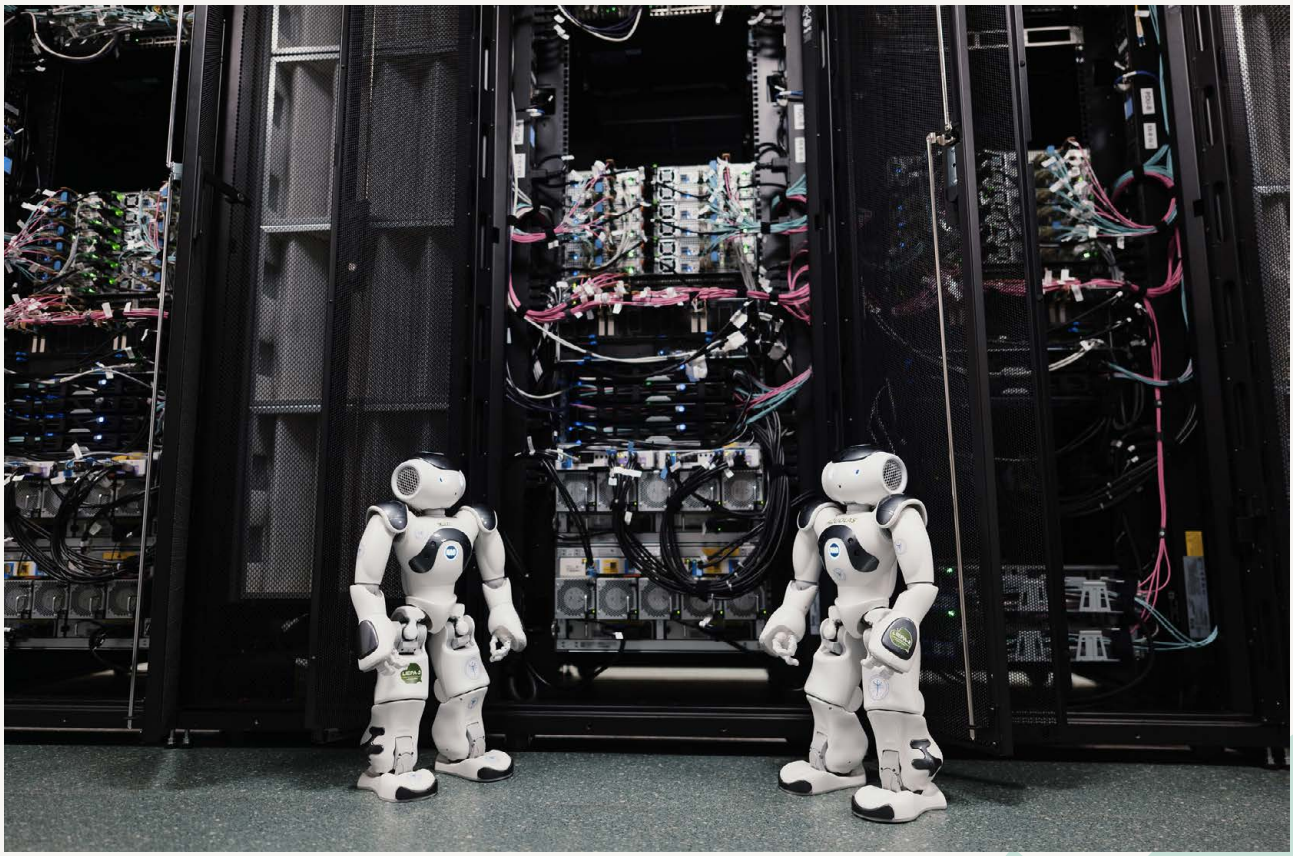
RI link (URL)	https://en.ktu.edu/research/research-at-divisions/rg-cyber-security/
Representing authority	Kaunas University of Technology
Participating bodies	–
By readiness to participate in international RI activities	Potential
Planned membership in international RI	GÉANT
International RI link (URL)	https://geant.org/
By location and organisation	Institutional
By phase of development	Operating

3.2.2. Lithuanian High-Performance Computing Network (LitGrid-HPC)

The Lithuanian High-Performance Computing Network (LitGrid-HPC), a high-performance computing RI, currently meets the needs of the academic, public and private sectors for CPU and GPU resource-based high-performance computing. The available national infrastructure allows users to carry out research using small and medium HPC resources and access to international infrastructures such as EGI and EuroHPC. The RI enables researchers from academia, business and public administrations to tackle complex scientific and technological challenges. LitGrid-HPC contributes to international cooperation, research participation and innovation.

THE NEED FOR AND PURPOSE OF THE RI

The purpose of the LitGrid-HPC infrastructure is to provide high-performance computing and cloud services for the development of research, experimentation and innovation. It is essential to enable Lithuanian scientists and researchers from various companies to address challenges related to quantum and classical physics applications, AI, machine learning, big data analytics, engineering and other advanced technologies. It is both beneficial and appropriate to invest in RI to take advantage of the latest developments in quantum computing and information technology. Through participation in international projects, information sharing and the development of skills in fields requiring high-performance computing, infrastructure supports economic, social and cultural development.



Public use image. Source – Vilnius University.

ACTIVITIES AND SERVICES OF THE RI

LitGrid-HPC operates in two specialised open-access centres at VU, offering HPC and cloud solutions for researchers, the public sector and businesses. The main research areas are materials science, molecular modelling, spectral studies, astrophysics, hydrometeorology and engineering computing. The RI also provides services related to machine learning and AI and big data analysis: in collaboration with business, RI is used to process laboratory research data. The VU HPC offers resource rental and outsourced research opportunities. The VU HPC supercomputer has a capacity of more than 0.5 PFlops, with a CPU peak real-time computational capability of 0.27 PFlops per task, and the EGI international infrastructure is used by more than 94,000 users.

INTERNATIONAL COOPERATION OF THE RI

Lithuania is also a member of EuroHPC, which is involved in the development of exascale supercomputers and quantum computers, thanks to the VU HPC supercomputer. The VU HPC centres at the Faculties of Physics and Mathematics and Informatics of Vilnius University actively collaborate with CERN, participate in various international projects and are part of the HPC communities, thus ensuring the exchange of knowledge and the development of innovation. The infrastructure is recognised as relevant, although CPU and GPU technologies are changing rapidly. This is particularly important to combine the different cloud and HPC technologies necessary for science and AI applications. Continuous upgrading of the infrastructure helps Lithuania to remain an important international player by providing advanced AI and parallel computing solutions. This strengthens the internationalisation of Lithuanian researchers, attracting SMEs to use the latest high-performance computing infrastructure and thus helping companies to create a higher level of added value.

RI link (URL)	http://www.supercomputing.vu.lt
Representing authority	Vilnius University
Participating bodies	A consortium is being set up
By readiness to participate in international RI activities	Established
Planned membership in international RI	EGI (full member)
International RI link (URL)	https://www.egi.eu/
By location and organisation	Institutional
By phase of development	Operating

3.3. Environment

3.3.1. Biodiversity and Geodiversity Data Centre (BioDatCom Centre

The Centre of Excellence for Biodiversity and Geodiversity Data (BioDatCom), established at the NRC, aims to bring together biological and geological data collections from various institutions in Lithuania and to ensure their public access. The centre addresses biodiversity conservation issues, digitises and publicises data and participates in international networks such as DiSSCO and CETAF. BioDatCom aims to promote innovation and contribute to sustainable ecosystem management strategies.

THE NEED FOR AND PURPOSE OF THE RI

The BioDatCom Centre aims to address the problems of access and centralisation of biological and geological data that hinder efficient research in systematics, palaeobotany and biodiversity. By pooling and publicising data, the centre will contribute to effective preservation of biodiversity, invasive species management and ecosystem monitoring. It will also promote eco-innovation, sustainable resource management and the preservation of the cultural heritage of biodiversity.

Public use image. Source – National Research Center.

ACTIVITIES AND SERVICES OF THE RI

The NRC carries out multidisciplinary research in various fields of biology and geology, using advanced technologies such as molecular biology, GIS, remote sensing, and radiochemical and geochemical analyses. As of 2020, the NRC has discovered more than 200 new species worldwide and contributes to global biodiversity conservation projects. The institution manages key biological collections, including collections of bird blood parasites and insects, which contribute to solving global ecological problems.

INTERNATIONAL COOPERATION OF THE RI

The BioDatCom Centre works closely with international partners, particularly in the CETAF network and CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) activities. It actively contributes to the development of global standards for the conservation of endangered species, participates in projects with foreign researchers and attracts international talent. By maintaining the BIGIS and invasive species databases, the centre supports global environmental and climate change research.

RI link (URL)	http://www.gamtostyrimai.lt
Representing authority	The State Scientific Research Institute Nature Research Centre
Participating bodies	–
By readiness to participate in international RI activities	Mature
Planned membership in international RI	DiSSCO
International RI link (URL)	https://www.dissco.eu/
By location and organisation	Institutional
By phase of development	Operating

3.3.2. Climate-smart Regenerative and Precision Agriculture RI (CLIMAGRO LT)

The Climate-smart Regenerative and Precision Agriculture RI (CLIMAGRO LT) is a joint initiative of Lithuanian universities and research institutions focusing on climate change mitigation, sustainable agriculture and the development of innovative precision agriculture technologies. It contributes to increasing the stability of agro-ecosystems and ensuring food security. CLIMAGRO LT cooperates with international organisations and aims to become an important centre of excellence for agricultural science and innovation in Lithuania and worldwide.

THE NEED FOR AND PURPOSE OF THE RI

CLIMAGRO LT addresses the critical challenges of climate change, land degradation and food security by promoting the development of regenerative and precision agriculture. This infrastructure is important for

Public use image. Source – Association "Nemunas Valley".

both research and the practical application of sustainable farming technologies, as well as for developing new talent and innovation. It helps to shape agricultural transformation strategies and contributes to the competitiveness of Lithuanian regions.

ACTIVITIES AND SERVICES OF THE RI

CLIMAGRO LT provides research and experimental development services related to agroecosystem research, soil health conservation and precision farming technologies. The infrastructure offers modern laboratories and digital data analysis tools to optimise agricultural processes and reduce environmental pollution. It also actively engages young researchers and collaborates with businesses to promote the introduction of new technologies and knowledge transfer.

INTERNATIONAL COOPERATION OF THE RI

CLIMAGRO LT seeks membership of the AnaEE-ERIC network, which addresses ecosystem management issues at global and regional scales. It participates in international Horizon Europe and other projects, and plans to expand its international cooperation by involving scientists from abroad and attracting young talent. CLIMAGRO LT aims to become a major centre of agricultural innovation, meeting the objectives of the EU's strategies and sustainable development.

RI link (URL)	https://slenis-nemunas.lt/mokslas/mokslo-centrai/
Representing authority	Nemunas Valley Association
Participating bodies	Vytautas Magnus University Academy of Agriculture, Lithuanian Research Centre for Agriculture and Forestry, Academy of Veterinary Sciences, Lithuanian University of Health Sciences
By readiness to participate in international RI activities	Mature
Planned membership in international RI	AnaEE-ERIC
International RI link (URL)	https://www.anaee.eu/about
By location and organisation	Joint
By phase of development	Operating

3.3.3. Centre of Excellence for Advanced Forestry (FOREST 4.0))

The Centre of Excellence for Advanced Forestry (FOREST 4.0) is a research infrastructure created by Vytautas Magnus University and the Lithuanian Research Centre for Agriculture and Forestry, which combines knowledge from forestry, AI, IT and the internet of things. The aim of the project is to develop digital technologies in forestry and forest-based bioeconomy. FOREST 4.0 aims to collect and process data to contribute to sustainable forestry development, climate change mitigation and the protection of forest ecosystems. This includes advanced data collection and analysis methods, and technological equipment for research and innovation in forestry.

THE NEED FOR AND PURPOSE OF THE RI

FOREST 4.0 infrastructure aims to address the global challenges posed by climate change, the degradation of forest ecosystems and the growing use of forests for biomass energy. Forests not only absorb carbon dioxide but also support biodiversity, making sustainable forestry essential. FOREST 4.0 aims to develop a sustainable forest bioeconomy, to ensure responsible forest management and to promote ecosystem resilience. The infrastructure also addresses the challenges of rural depopulation and a wider understanding of the values of forests by incorporating technological solutions.

Public use image. Source – Vytautas Magnus University.

ACTIVITIES AND SERVICES OF THE RI

FOREST 4.0 provides a scientific infrastructure comprising fixed and mobile laboratories, advanced computing resources and tools. This infrastructure enables research and service delivery including data collection, curation, computational capabilities and advanced forestry strategies. The centre focuses on forestry data analysis and modelling, digital forest monitoring solutions, climate change impact assessment and forest ecosystem health forecasting. It also carries out research in the fields of AI, remote sensing, evolutionary genetics and forest biomass.

INTERNATIONAL COOPERATION OF THE RI

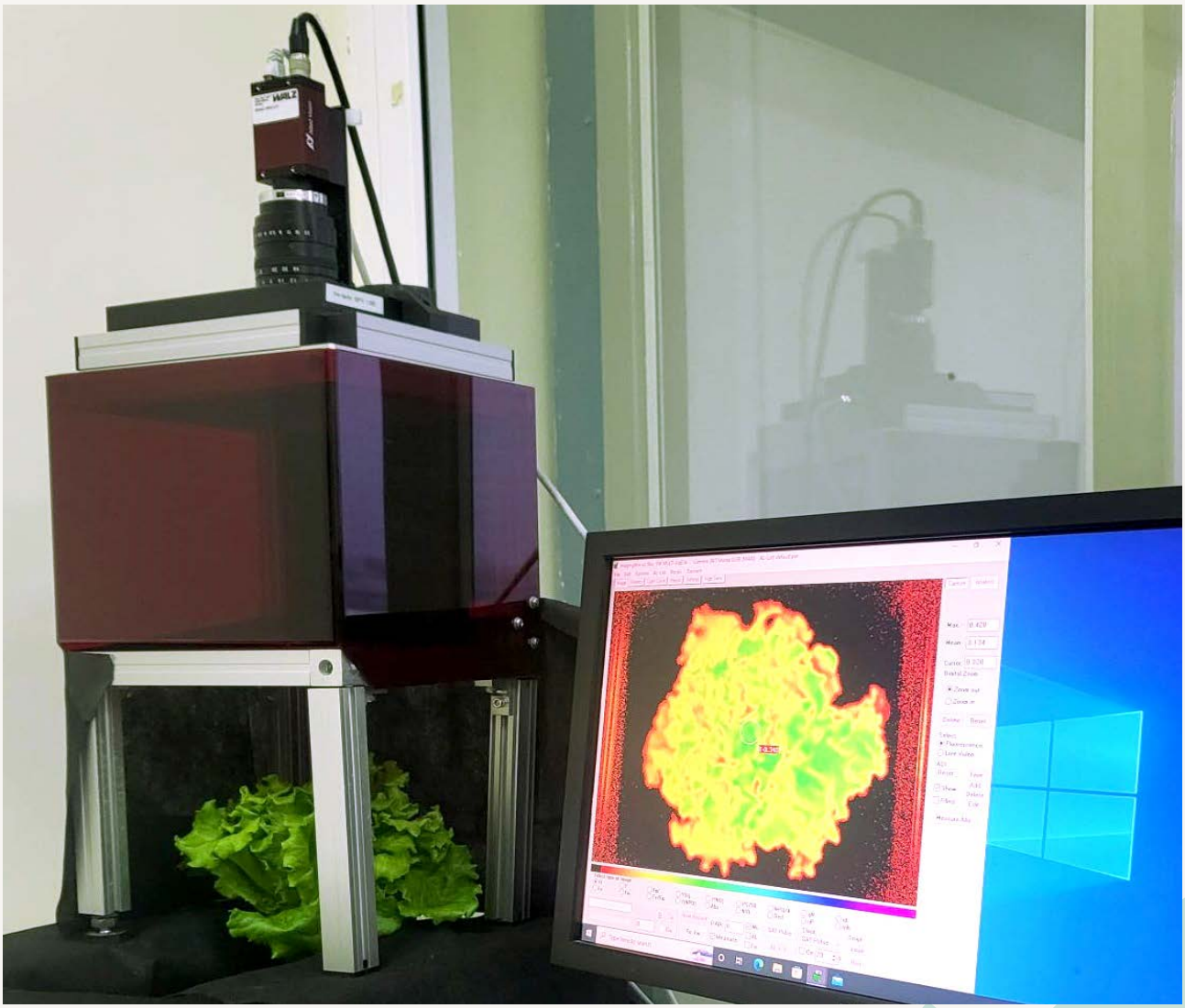
FOREST 4.0 is actively pursuing international cooperation by joining organisations such as IUFRO and EFI. The centre also plans to join international research infrastructures such as ICOS ERIC, LifeWatch ERIC and EMPHASIS. In collaboration with international partners, FOREST 4.0 is involved in networking activities related to agriculture, forestry and rural development, thus enhancing innovation and knowledge exchange in forestry.

RI link (URL)	www.forest40.lt
Representing authority	Vytautas Magnus University
Participating bodies	Lithuanian Research Centre for Agriculture and Forestry
By readiness to participate in international RI activities	Potential
Planned membership in international RI	ICOS ERIC ILTER / eLTER RI LifeWatch ERIC Emphasis
International RI link (URL)	https://www.icos-cp.eu https://www.ilter.network/ https://elter-ri.eu/ https://www.lifewatch.eu https://emphasis.plant-phenotyping.eu/
By location and organisation	Joint
By phase of development	Starting operation

3.4. Health and Food

3.4.1. Plant Phenotyping Infrastructure for Sustainable Production of Functional Food (PHENOPlant)

The Plant Phenotyping Infrastructure for Sustainable Production of Functional Food (PHENOPlant) is a research infrastructure for analysing qualitative and quantitative traits in plants in relation to environmental and soil conditions. It connects the Lithuanian Research Centre for Agriculture and Forestry (LAMMC) and VMU, and aims to be a member of the international EMPHASIS infrastructure. This infrastructure is important for the development of future plant varieties, the application of advanced technologies and techniques such as the use of drones, satellite and robotic systems, and the promotion of sustainable food production.



Public use image. Source – Lithuanian Research Centre for Agriculture and Forestry.

THE NEED FOR AND PURPOSE OF THE RI

PHENOPlant aims to accelerate the plant breeding process by applying the latest technologies to ensure plant resistance to climate change and pathogens. The RI brings together high-level scientists from LAMMC and VMU to develop and improve phenotyping, precision agriculture and genotyping technologies. It is not only important for the natural and agricultural sciences, but also benefits the food industry, farmers and social partners, fostering innovation and societal progress.

ACTIVITIES AND SERVICES OF THE RI

The PHENOPlant RI provides open-access services in the field of plant phenotyping and genetic data analysis for precision agriculture and sustainable farming methods. The infrastructure allows users to carry out research, request specific services or collaborate on R&D projects. PHENOPlant also promotes international collaboration, talent attraction, events and consultancy.

INTERNATIONAL COOPERATION OF THE RI

PHENOPlant actively cooperates with international organisations such as EMPHASIS and the Nordic-Baltic Plant Phenotyping Network (NBPPN). In cooperation with the University of Copenhagen, a PHENOPlant Centre of Excellence is planned to promote international research and the development of young scientists. Membership of international networks will increase the visibility of Lithuanian scientists and accelerate the development of plant phenotyping.

RI link (URL)	–
Representing authority	Lithuanian Research Centre for Agriculture and Forestry
Participating bodies	Vytautas Magnus University
By readiness to participate in international RI activities	Potential
Planned membership in international RI	EMPHASIS
International RI link (URL)	https://emphasis.plant-phenotyping.eu/
By location and organisation	Joint
By phase of development	Starting operation

3.4.2. European Neuroscience Research Infrastructure in Lithuania (EBRAINS Lithuania)

The European Neuroscience Research Infrastructure in Lithuania (EBRAINS-LT) is a research infrastructure dedicated to conducting top-level international research in basic neuroscience, medicine and AI, to translating innovative research results into clinical practice, and to advancing education in the

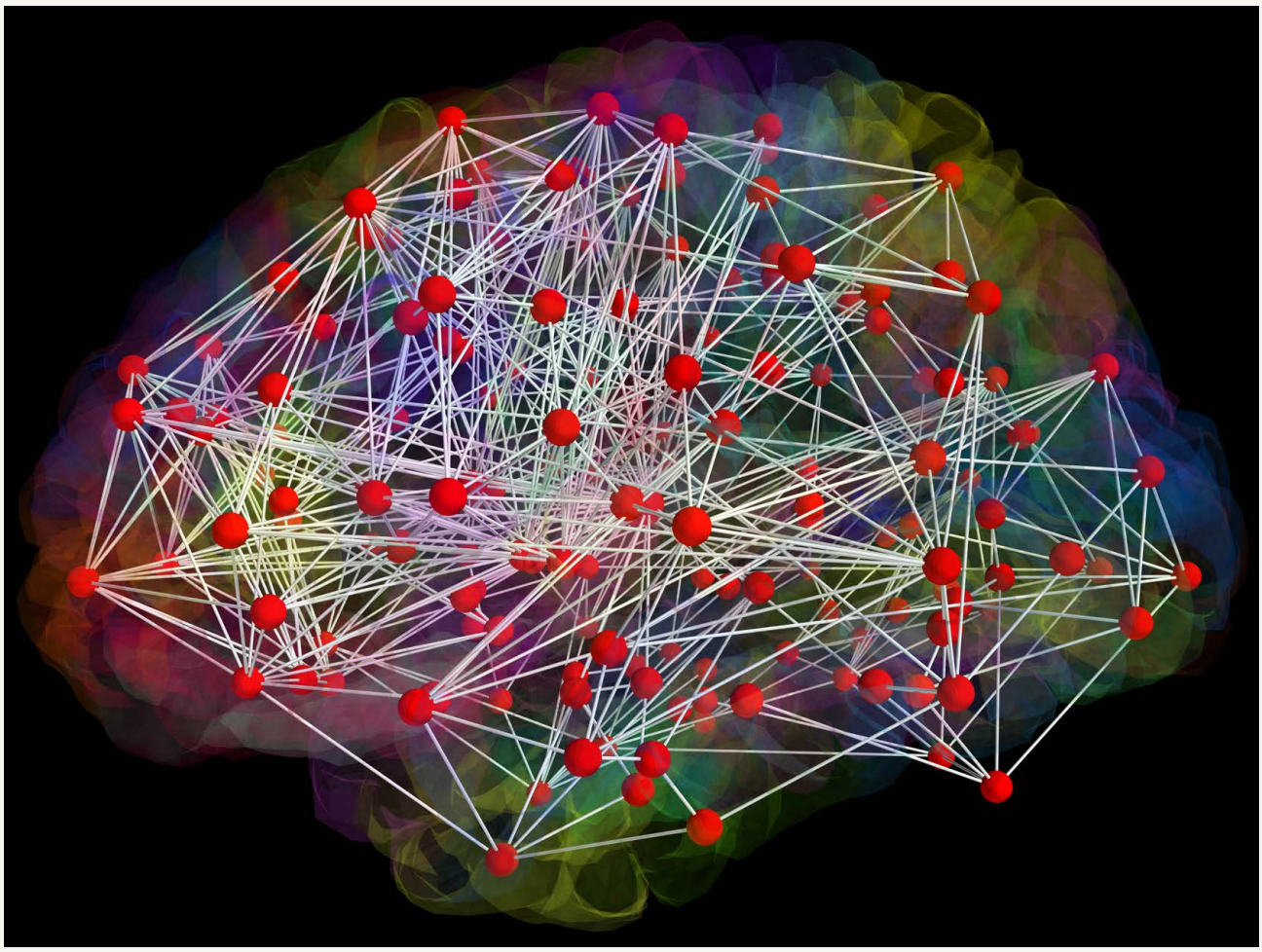


Image source – INSA-Aix-Marseille University.

interdisciplinary field of neuroscience. EBRAINS-LT is part of the European Brain Research Infrastructures (EBRAINS) in Lithuania.

The objectives of EBRAINS-LT are to increase the research and innovation potential in Lithuania in the interdisciplinary EBRAINS scientific fields, to develop infrastructure and conduct collaborative research at the highest level. This includes representing Lithuania's interests in the EBRAINS strategic planning and policymaking process, promoting EBRAINS research and achievements, and educating the public about brain research and health issues.

THE NEED FOR AND PURPOSE OF THE RI

EBRAINS-LT aims to strengthen interdisciplinary research in basic neuroscience, medicine, neurotechnology and AI to better understand how the brain works and to develop advanced therapeutic technologies. The objectives of the infrastructure are to promote the advancement of research in Lithuania, to bring innovations in the diagnosis, treatment, rehabilitation and prevention of brain diseases into clinical practice. This will create an open environment for the sharing of scientific data and to nurture young scientists, promote the dissemination of information about neuroscience research and educate the public about brain health.

ACTIVITIES AND SERVICES OF THE RI

EBRAINS-LT uses state-of-the-art AI-based techniques to analyse, gather and integrate data on brain diseases in addition to researching theoretical and computational modelling of brain processes. The infrastructure provides services for the development of personalised digital brain twins, medical data analysis, theoretical and computational brain models, training young scientists in neuroscience, medicine and AI, and education of the public on brain health issues.

INTERNATIONAL COOPERATION OF THE RI

EBRAINS-LT is part of the international EBRAINS network, collaborating with major European neuroscience centres. This infrastructure promotes interdisciplinary research and sharing scientific knowledge across Europe. EBRAINS-LT contributes to the creation and application of cutting-edge brain research technology, helps create clinical solutions and trains the next generation of scientists in a global setting.

RI link (URL)	–
Representing authority	Lithuanian University of Health Sciences
Participating bodies	Kaunas University of Technology, Vytautas Magnus University, Hospital of Lithuanian University of Health Sciences Kauno Klinikos, Kaunas Hospital of the Lithuanian University of Health Sciences
By readiness to participate in international RI activities	Mature
Planned membership in international RI	EBRAINS
International RI link (URL)	www.ebrains.eu
By location and organisation	Joint
By phase of development	Operating

3.4.3. Experimental Animal RI for Disease Modelling (RILAD)

The Experimental Animal RI for Disease Modelling (RILAD) brings together Vilnius and Lithuanian Universities of Health Sciences and the State Research Institute Centre for Innovative Medicine to develop accurate animal models that can be used for research on human diseases and for finding treatment strategies. This infrastructure will promote the development of the pharmaceutical industry and research in Lithuania, strengthening the country's position in international biotechnology. To foster international cooperation, RILAD will seek to join the INFRAFRONTIER consortium, which uses animal models to study the genetic causes of human diseases.

THE NEED FOR AND PURPOSE OF THE RI

RILAD's membership in the INFRAFRONTIER infrastructure is of great scientific, technological, economic and social importance for Lithuania. New medicinal technologies, dosage forms, diagnostic tools and multidisciplinary research will all benefit from this infrastructure. In addition to making Lithuania more competitive in biotechnology, a robust experimental animal infrastructure will draw research funding and spur economic expansion. Additionally, it will benefit the healthcare system by lowering the expenses associated with chronic illnesses

ACTIVITIES AND SERVICES OF THE RI

RILAD's infrastructure includes the provision of animal housing, the development of specialised equipment and the development of disease models for human disease. It focuses on compliance with animal welfare standards, advice and training, as well as the introduction of modern research technologies such as gene editing and advanced imaging tools. Key services include the development of animal models for human disease, the evaluation of therapeutic efficacy, and access to bioinformatics and statistical methods.

INTERNATIONAL COOPERATION OF THE RI

Membership of INFRAFRONTIER will provide access to EMMA, Europe's largest repository of mouse models, and will allow participation in international research and access to systematic phenotyping. INFRAFRONTIER training and workshops will contribute to the development of technical and scientific expertise, stimulate the development of new technologies, and enhance the exchange of knowledge and experience.

RI link (URL)	–
Representing authority	Vilnius University
Participating bodies	Lithuanian University of Health Sciences, State Research Institute Centre for Innovative Medicine
By readiness to participate in international RI activities	Potential
Planned membership in international RI	INFRAFRONTIER
International RI link (URL)	https://www.infrafrontier.eu/
By location and organisation	Joint
By phase of development	Starting operation

3.4.4. Centre for Computational, Structural and Systems Biology (CossyBio)

The Centre of Computational, Structural and Systems Biology (CossyBio) is a networked national infrastructure in Lithuania for basic and applied research on both biomolecules and biological systems. It enables researchers to analyse biological processes at different scales of organisation: from individual molecules and their interactions, through cellular and intracellular processes, to complex information flows in living systems. CossyBio facilitates and supports research in Lithuania, by taking advantage of the benefits of EMBL and INSTRUCT-ERIC membership.

THE NEED FOR AND PURPOSE OF THE RI

The CossyBio project has created and continues to build an internationally competitive research and experimental development (R&D) infrastructure that enables life and health scientists to use advanced technologies. This significantly accelerates the study of fundamental biological processes and their application to the diagnosis, treatment and development of biomedical products. This reduces the time needed to translate a fundamental scientific discovery into a socially useful and cost-effective service or product. At the same time, it promotes the growth of competence and competitiveness of the country's scientists and their involvement in international scientific networks, contributing to Lithuania's high-tech progress.

Public use image. Source – Vilnius University.

ACTIVITIES AND SERVICES OF THE RI

CossyBio provides services in three centres. For the purification and crystallisation of proteins and their complexes, and for structural investigations of combined proteins and nucleic acids utilising high-resolution technologies, the Structural Biology Centre offers guidance and instrumental resources. Three experimental infrastructure platforms make up the Centre for Systems Biology: cutting-edge biological imaging platforms, mass spectrometry and biomolecule infrastructure for proteome analysis, and genome research technologies enabled by DNA sequencing. The third centre offers services for processing and storing bioinformatics and other large-scale data, and it is devoted to computational biology. These facilities are all open to the public and offer services to researchers and businesses in Lithuania and abroad.

INTERNATIONAL COOPERATION OF THE RI

The prerequisites for joining the international EMBL and INSTRUCT-ERIC structures have been established by the CossyBio project. Scientists in Lithuania who are members of EMBL and INSTRUCT-ERIC can participate in collaborative European projects, use cutting-edge technology that is not yet available in our nation, and integrate into European educational and scientific dissemination initiatives. This unquestionably improves Lithuania's integration into the scientific infrastructure of Europe and fosters innovation. It is significant to note that CossyBio equipment is widely utilised for a variety of research projects conducted in partnership with international researchers and the corporate sector.

RI link (URL)	https://2014.esinvesticijos.lt/lt.//finansavimas/ paraiskos_ir_ projektai/kompiuterines-strukturines-ir-sistemu-biologijos-centras-cossybio
Representing authority	Vilnius University
Participating bodies	Vilnius University, Lithuanian University of Health Sciences, National Cancer Institute
By readiness to participate in international RI activities	Established
Planned membership in international RI	EMBL, EMBC/EMBO (full member) INSTRUCT-ERIC (full member)
International RI link (URL)	https://www.embl.org/ https://embc.embo.org/ https://www.embo.org/ https://instruct-eric.org/
By location and organisation	Joint
By phase of development	Operating

3.4.5. Human Biological Resources Centre (HBRC)

The HBRC project for 2019–2023 has successfully achieved its main goal – Lithuania has become a full member of the international research infrastructure BBMRI-ERIC. The project has created a modern infrastructure for a national biobank network. This is an important step in Lithuania's science and innovation, strengthening the country's position in the global research landscape.

THE NEED FOR AND PURPOSE OF THE RI

The primary goal of the HBRC is to enhance public health by encouraging the sustainable and appropriate use of biomolecules and human biological resources. Researchers in Lithuania and other nations can access the best biobank collections thanks to this infrastructure, which is standardised in accordance with the EU's guidelines for good biobanking practices. These guidelines emphasise the need for open science and digitisation, which are especially important when it comes to managing sensitive data in the healthcare industry. The HBRC makes it easier for Lithuanian scientific institutions to take part in international research projects and programmes. It also provides opportunities for the advancement of advanced biotechnologies, modern biomedical research and new instruments for disease prevention, diagnosis, treatment and monitoring.

Public use image. Source – National Cancer Institute.

ACTIVITIES AND SERVICES OF THE RI

The HBRC biobanks manage collections of oncological, haematological, infectious, cardiac, rheumatological and population samples using state-of-the-art refrigeration and storage technologies, including living tissues and cells; large-scale pathological digitisation projects using AI solutions; state-of-the-art (epi)genomic, metabolomics and other methodologies are applied to biomedical research. The integrated information systems developed under the project ensure high-quality management of biological samples and related health information, and efficient delivery of data to researchers.

INTERNATIONAL COOPERATION OF THE RI

BBMRI-ERIC involves 23 countries. The research of this international infrastructure and its members covers the key areas of cancer, rare diseases, COVID-19 and infectious diseases as well as focusing on paediatric diseases, while harnessing the potential of new technologies. Within the BBMRI-ERIC network, the HBRC actively collaborates with partners from neighbouring countries, as well as from Germany, the Netherlands, Switzerland and other countries. Particular attention is also paid to scientific links with researchers in Japan and Taiwan. This broad international collaboration strengthens the quality of research and innovation in the biomedical field.

RI link (URL)	https://www.bbmri-eric.eu/national-nodes/lithuania/
Representing authority	National Cancer Institute
Participating bodies	Vilnius University Hospital Santaros Clinics, Vilnius University, State Research Institute Innovative Medicine Centre, Lithuanian University of Health Sciences, Kaunas Clinics, Lithuanian University of Health Sciences Hospital
By readiness to participate in international RI activities	Established
Planned membership in international RI	BBMRI-ERIC (full member)
International RI link (URL)	https://www.bbmri-eric.eu/about/
By location and organisation	Institutional
By phase of development	Operating

3.5. Physical Sciences and Engineering

3.5.1. RI for Functional Materials for Sustainable Energy, Environment and Health (REFRESH)

The RI for Functional Materials for Sustainable Energy, Environment and Health (REFRESH) is a research infrastructure focused on the synthesis and application of functional materials in the fields of renewable energy, environment and health. REFRESH brings together Kaunas University of Technology's Faculty of Chemical Technology and the Food Institute to address the challenges of climate change, sustainability and health, and collaborates with international research organisations and industry to develop innovative technologies. REFRESH is internationally competitive in the development of high-efficiency organic photoconductors for perovskite solar cells and organic light-emitting diodes (OLEDs). From a health perspective, REFRESH is dedicated to the development of bioactive compounds with antioxidant, anti-inflammatory and anti-cancer properties, and biomedical materials, including biocompatible polymers and advanced bioactive delivery systems. REFRESH conducts research in functional and preventative food matrices, focusing on microbiome-targeted bioactive compounds, personalised nutrition and biotechnological innovations, while advancing circular economy models to optimise food supply chains. It also develops strategies to reduce food loss and waste and synthesises high-value-added biomaterials for improving health.

THE NEED FOR AND PURPOSE OF THE RI

REFRESH was established to address major social, economic and environmental challenges related to the energy transition to renewable sources, the development of green building materials and pollutant separation technologies, and the synthesis of biologically active compounds for health. Infrastructure is important for Lithuania's green energy development to reduce dependence on fossil fuels and for climate change mitigation. REFRESH contributes to health by developing bioactive compounds and biomedical materials to improve the quality of healthcare and reduce costs. Additionally, it conducts research on sustainable food systems, focusing on alternative protein biotechnologies, safe consumption practices, and circular economy-based food supply chain solutions to reduce the environmental impact of nutrition. Through an interdisciplinary approach, REFRESH aims to foster technological progress in Lithuania and contribute to addressing global environmental and health challenges.

ACTIVITIES AND SERVICES OF THE RI

Advanced research on high-efficiency photovoltaics, OLEDs, bioactive substances that promote health, alternative protein biotechnologies and biomedical materials for food and medicinal purposes are part of REFRESH. In this sense, REFRESH prioritises health, environmental sustainability and renewable energy. REFRESH offers specialised applied research, advice, and technology transfer services to businesses, including the synthesis and characterisation of novel materials. Industries using cutting-edge technologies in the areas of

biotechnology, food, renewable energy and environmental protection will find these services highly valuable. REFRESH seeks to foster innovation and commercialise research findings in partnership with industry.

INTERNATIONAL COOPERATION OF THE RI

REFRESH is actively involved in international projects such as Horizon Europe and collaborates with global academic and industrial partners. Through these global partnerships, REFRESH is able to take advantage of cutting-edge infrastructure, exchange knowledge and create opportunities for the commercialisation of research findings. This guarantees that advancements in fields such as biomedical materials, alternative protein biotechnologies, and sustainable functional food materials, including bioactive food compounds, are translated into practical applications for society. In this way, REFRESH enhances its global standing, draws in foreign talent and aids Lithuania in establishing itself in the global market for research and technology.

RI link (URL)	https://fct.ktu.edu/ https://food.ktu.edu/
Representing authority	Kaunas University of Technology
Participating bodies	–
By readiness to participate in international RI activities	Mature
Planned membership in international RI	CERIC ERIC
International RI link (URL)	https://www.ceric-eric.eu/
By location and organisation	Institutional
By phase of development	Operating

3.5.2. Centre for Innovative Chemistry (INNOCHEM)

INNOCHEM brings together the research infrastructures of the Centre of Physical and Technological Sciences (CPTS) and the Faculty of Chemistry and Geosciences of Vilnius University (FCHG VU), to integrate them into European and international RIs and their networks, and to achieve breakthroughs in chemistry. It focuses on two main areas: the chemistry of materials for energy (renewable energy solutions) and the application of bio-, organic and hybrid materials in functional medicine and robotics. INNOCHEM carries out interdisciplinary research, combining different competencies and resources to contribute to scientific discovery and innovation.

THE NEED FOR AND PURPOSE OF THE RI

The INNOCHEM RI was established to improve research quality, international competitiveness and Lithuania's potential in chemistry and materials science. The infrastructure facilitates comprehension of the intricate

physical, chemical and materials engineering processes necessary for contemporary science and industry. INNOCHEM facilitates the training of new scientists, improves research and pools resources. It supports the creation of cutting-edge goods and global initiatives, encouraging digital transformation and drawing in talent.

ACTIVITIES AND SERVICES OF THE RI

INNOCHEM integrates the infrastructure of CPTS and FCHG VU in six specialised laboratories, where research is carried out in the fields of synthesis of new materials, electrochemical technologies, photochemistry, bio- and hybrid materials, soft robotics and prototyping. The laboratories are equipped with advanced equipment for structural, chemical and electrochemical analysis of materials. New equipment is planned to increase research capabilities and enable the development of advanced material solutions.

INTERNATIONAL COOPERATION OF THE RI

INNOCHEM actively collaborates with international scientific and industrial partners, including CNRS (Centre national de la recherche scientifique – France), the Leibniz Institute (Germany), Thermo Fisher Scientific (USA) and others. Participation in international RI, such as CERIC ERIC, will allow the development of research projects and open-access services. The centre will strengthen the integration of Lithuanian research into international innovation ecosystems.

RI link (URL)	https://www.innochem.lt
Representing authority	State Research Institute Centre for Physical Sciences and Technology
Participating bodies	Vilnius University
By readiness to participate in international RI activities	Mature
Planned membership in international RI	CERIC ERIC IAM4EU EMMC ELLIS
International RI link (URL)	https://www.ceric-eric.eu https://emmc.eu https://ellis.eu https://www.ami2030.eu https://www.iam-i.eu
By location and organisation	Joint
By phase of development	Operating

3.5.3. Lithuanian Particle Physics Consortium (Lietuvos dalelių fizikos konsorciumas – LDFK)

This is a national infrastructure coordinating the activities of Lithuanian scientists in connection with the European Council for Nuclear Research (Conseil Européen pour la Recherche Nucléaire – CERN). The Lithuanian Particle Physics Consortium enables Lithuanian scientists and students to get involved in CERN experiments and to use its facilities and resources. The consortium is also involved in various educational activities to encourage young people to pursue scientific and engineering disciplines, and to increase their knowledge in particle physics.

THE NEED FOR AND PURPOSE OF THE RI

Lithuania became an Associate Member of CERN in 2018, which created a need to unite and promote CERN-related activities. The LDFK was established in 2022 to address scientific and technological challenges by involving Lithuanian researchers in international CERN experiments and projects. The LDFK helps Lithuanian scientists, students, pupils and entrepreneurs to make effective use of the opportunities offered by CERN, encourages businesses to participate in CERN projects and procurements, and attracts highly skilled professionals. In addition, LDFK aims to implement CERN's best practices in Lithuania, particularly in the fields of open science and education.

ACTIVITIES AND SERVICES OF THE RI

Characterising radiation detectors and their materials, developing specialised IT tools, and conducting and analysing data from the two substantial CMS and LHCb investigations are just a few of the CERN experiments in which the LDFK experts are actively involved. For CERN-related work, the consortium also grants access to Lithuania's scientific infrastructure. To introduce CERN innovations to the Lithuanian market, the LDFK collaborates with businesses, hosts educational events for students and schoolchildren, and funds internships for scientists and students at CERN.

INTERNATIONAL COOPERATION OF THE RI

LDFK participates in international CERN programmes such as the CMS and LHCb experiments, the Tracker, n_TOF and Detector Research & Development (DRD) collaborations, and is a member of the CERN Baltic Group, which seeks to coordinate the activities of the three Baltic states at CERN. The consortium participates in various open science and education initiatives such as SCOAP3 and the Baltic Teacher programme. The LDFK scientists work together with colleagues from 40 countries, contributing to the worldwide development of particle physics research and technology.

RI link (URL)	https://www.daleliufizika.lt/
Representing authority	Vilnius University
Participating bodies	Kaunas University of Technology, Lithuanian University of Health Sciences, Lithuanian Energy Institute
By readiness to participate in international RI activities	Established
Planned membership in international RI	CERN (full member)
International RI link (URL)	https://www.home.cern/
By location and organisation	Joint
By phase of development	Operating

3.5.4. Open Access Centre for Micro-, Nanotechnologiy and Analysis (MNAC)

The Open Access Centre for Micro- and Nanotechnology Analysis (MNAC) is a research infrastructure for smart specialisation in innovative manufacturing processes, materials and technologies, and for global research in the areas of energy and sustainable environments. It offers a variety of technical and analytical services, such as deep reactive ion etching, electron beam lithography, the synthesis of nanoparticles, and material chemical and structural analysis. The MNAC is a member of the European Nanotechnology Laboratory Network (EuroNanoLab) and collaborates with other universities and research facilities overseas.

THE NEED FOR AND PURPOSE OF THE RI

The MNAC aims to ensure high-quality research and innovation, to help modern industry develop new technologies and advanced materials, and to contribute to the development of new directions in European science. Its priorities include the development of advanced and climate-neutral materials, micro- and nanotechnologies, solar energy, photonics and laser technologies, and solutions in medical diagnostics.

ACTIVITIES AND SERVICES OF THE RI

Deep reactive ion etching, electron beam and UV lithography, optical and electron spectroscopy, atomic force microscopy and ultra-clean-air facilities – these are just a few of the technological and analytical services offered by the MNAC in the fields of micro- and nanotechnology, and the study of the atomic and chemical structure of materials and structures. Innovation in photonics, materials science and renewable energy is fuelled by the centre's research. MNAC provides services to corporations and scientific institutes, both domestically and internationally.

Public use image. Source – Kaunas University of Technology.

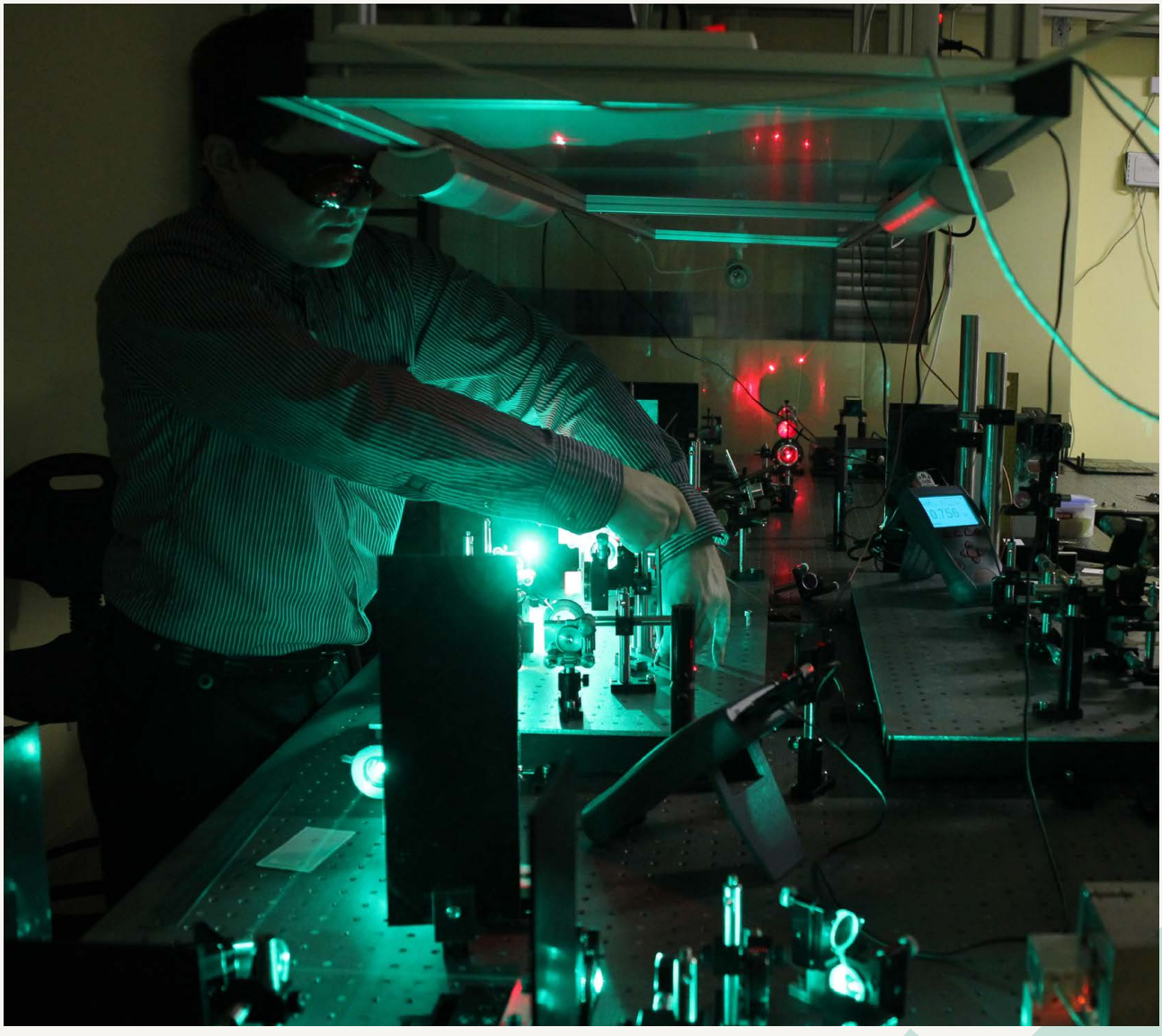
INTERNATIONAL COOPERATION OF THE RI

The MNAC is a member of EuroNanoLab, an international network of more than 40 nanotechnology centres in Europe. The centre actively cooperates with international partners from Japan, France, Denmark, South Korea and other countries. The MNAC strengthens its scientific excellence by participating in Horizon Europe, European Space Agency, Eureka and other international projects, attracting foreign researchers and PhD students.

RI link (URL)	https://medziagos.ktu.edu/#mokslo-infrastruktura-ir-paslaugos
Representing authority	Kaunas University of Technology
Participating bodies	–
By readiness to participate in international RI activities	Mature
Planned membership in international RI	EURONANOLAB
International RI link (URL)	https://euronanolab.eu/
By location and organisation	Institutional
By phase of development	Operating

3.5.5. High Intensity and Wide Wavelength Range Ultrashort Pulse Lasers for National and International Access RI (Laser RI)

The High Intensity and Wide Wavelength Range Ultrashort Pulse Lasers for National and International Access RI (Laser RI) brings together the Laser Research Centre of the Faculty of Physics at Vilnius University (LRC VU) and the Laser Technology Department of the Centre for Physical Sciences and Technology (CPTS LTS), both of which play a pivotal role in the advancement of laser research in the country. The main research areas include the generation of ultrashort laser pulses over a broad range of wavelengths, light-matter interaction, nonlinear optics, ultrafast processes, and laser technologies for nano- and micro-processing of various materials. This infrastructure is also available to researchers from other institutions through Laserlab-Europe AISBL and bilateral agreements, supporting international scientific and applied research in advanced laser techniques and prototype development. High-tech companies are also welcome to utilise this infrastructure.



Public use image. Source – Vilnius University.

THE NEED AND PURPOSE

Laser RI brings together human resources and expertise to advance both fundamental and applied research in the Lithuanian laser industry. Equipped with state-of-the-art facilities and active in international research infrastructure initiatives, it strengthens global collaboration, drives new research directions, enhances scientific expertise, and develops researchers' competencies. Key focus areas include laser optical components, laser material nano- and micro-processing, and ultrashort pulse lasers, which enhance research synergy and technological innovation in joint laboratories. Additionally, Laser RI supports European laser initiatives like the Extreme Light Infrastructure (ELI), contributing to the expansion of ultra-high-intensity laser science.

ACTIVITIES AND SERVICES

Laser RI provides access to unique laser facilities for research in ultrashort pulse lasers, nonlinear optical phenomena, laser-matter interactions and laser applications. With internationally renowned researchers from VU LTC and CPTS LTS, it ensures excellence in scientific research. Additionally, Laser RI offers services to the industry, including laser-based product testing, precision measurements and collaborative development of innovative solutions for scientific and industrial applications.

INTERNATIONAL COOPERATION

Since 2004, Laser RI has provided international access through Laserlab-Europe, a European research network that unites 33 partners from 16 European countries. It actively participates in Horizon 2020 and Horizon Europe projects, such as PULSATE, Multiscan 3D and iFAST, contributing to advancements in industrial laser technologies. Laser RI strengthens international collaboration by integrating into the Extreme Light Infrastructure (ELI) research network, utilising ELI's laser facilities in the Czech Republic and Hungary

RI link (URL)	–
Representing authority	Vilnius University
Participating bodies	State Research Institute Centre for Physical Sciences and Technology
By readiness to participate in international RI activities	Established
Planned membership in international RI	ELI ERIC (full member)
International RI link (URL)	https://eli-laser.eu/
By location and organisation	Joint
By phase of development	Operating

3.5.6. Vilnius University Molėtai Astronomical Observatory (VU MAO)

Vilnius University Molėtai Astronomical Observatory (VU MAO) is the only professional astronomical observatory in Lithuania, which has been operating since 1969. Observations are carried out with three telescopes, one of which is the largest in northern Europe. The observatory is equipped with modern and unique scientific instruments such as the Vilnius University Echelle Spectrograph (VUES), a high-resolution spectrograph. The VU MAO scientists carry out research on stellar and galactic evolution, observations of transits of variable stars and exoplanets, and searches for asteroids, comets and other objects dangerous to the Earth. The observatory is actively involved in study and educational activities, organising tours, public lectures and international summer schools. The VU MAO is an open-access centre, open to all interested researchers.

THE NEED FOR AND PURPOSE OF THE RI

The VU MAO was founded to continue the Lithuanian astronomical tradition and to develop advanced astronomy and astrophysics research. The main goal of the observatory is to carry out fundamental research on the universe and to remain one of the most modern observatories operating small and medium-class telescopes. Observations at the VU MAO can help answer fundamental questions about how stars, galaxies and planets form and evolve. Located at a relatively high latitude, the VU MAO offers the opportunity to use modern instruments to study objects that are often inaccessible to other observatories. This infrastructure is important both nationally and internationally, as it helps Lithuania to participate in important astronomical projects.

Public use image. Source – Vilnius University.

ACTIVITIES AND SERVICES OF THE RI

The VU MAO's primary tasks are observing celestial bodies and analysing the data that is obtained. In addition to helping multinational space mission programmes such as NASA's TESS and ESA's PLATO succeed, the observatory employs its equipment to investigate variable stars, asteroids and other objects that pose a threat to Earth. It has also participated in six projects supported by the European Commission. Through public lectures, seminars and international summer schools for students and astronomy lovers, the VU MAO actively contributes to the public's understanding of astronomical science in addition to its scientific endeavours. Researchers from Lithuania and other countries are welcome to apply for and use the telescopes and other research equipment at the VU MAO facilities, which are open-access.

INTERNATIONAL COOPERATION OF THE RI

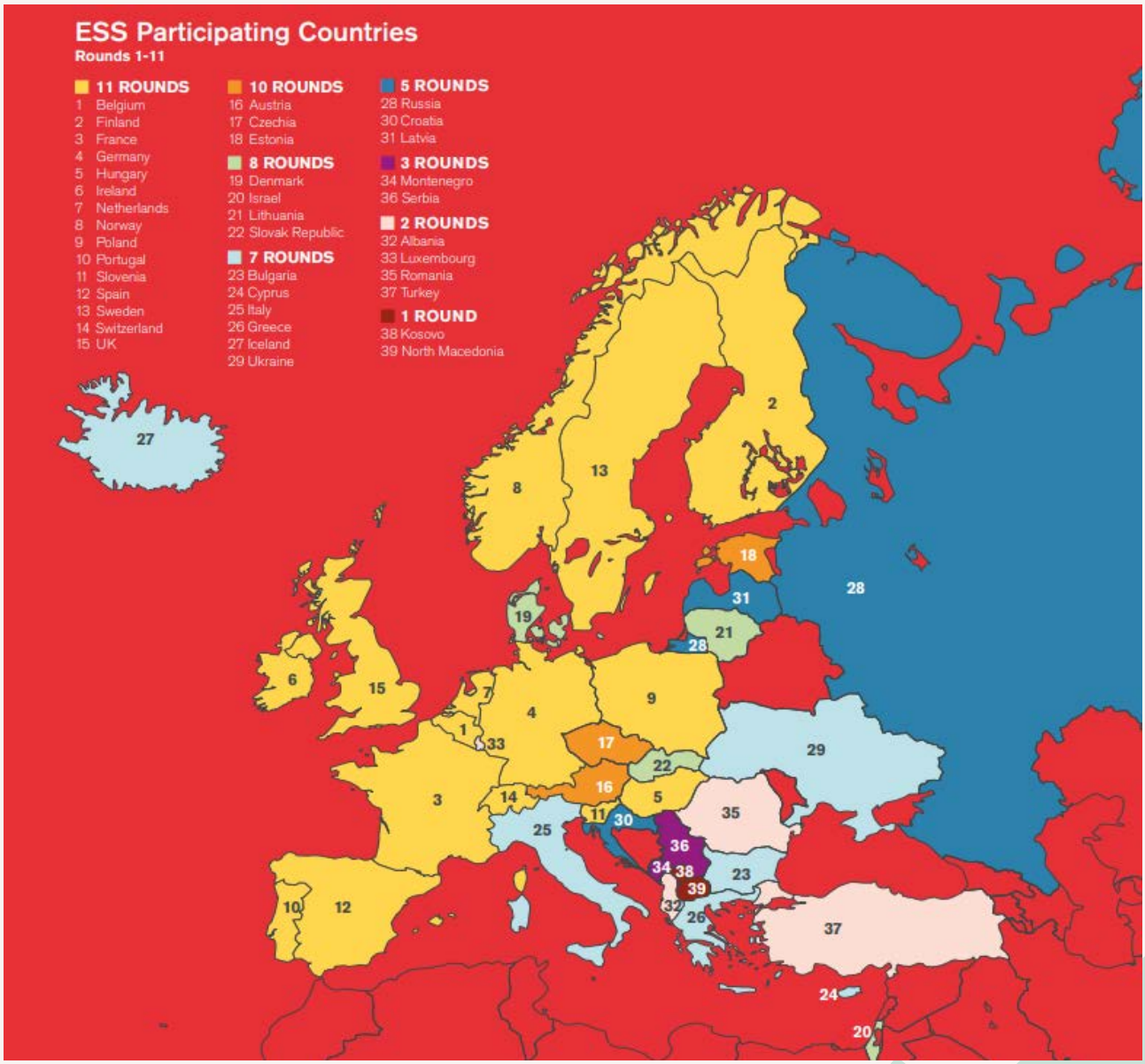
The VU MAO is involved in many international projects, including the WEAVE consortium, the Whole Earth Telescope Consortium and the Europlanet Telescope Network. The observatory's facilities are also used in other important astronomical research projects such as Gaia-alerts, Kepler, TESS, PLATO and ExoClock. The VU MAO is continuously upgraded with the latest technologies to maintain its international competitiveness and to expand its collaborative network.

RI link (URL)	http://mao.tfai.vu.lt
Representing authority	Vilnius University
Participating bodies	–
By readiness to participate in international RI activities	Mature
Planned membership in international RI	ETN WEAVE WET
International RI link (URL)	https://www.europlanet-society.org/europlanet-2024-ri/europlanet-telescope-network/ https://weave-project.atlassian.net/wiki/spaces/WEAVE/overview https://www.physics.udel.edu/gp/darc/wet/
By location and organisation	Institutional
By phase of development	Operating

3.6. Social Sciences and Humanities

3.6.1. RI for European Social Survey (ESS LT)

The ESS is an international social survey carried out across Europe every two years from 2001. It provides high-quality, open-access data measuring public attitudes, beliefs and behaviour. The survey meets the highest methodological standards in the social sciences and ensures the possibility to monitor and analyse social development processes, and to inform both discussion and decisions in research and policy making. The survey covers almost 40 countries, and Lithuania is a member of ERIC. Participation in the ESS allows



Public use image. Source – Vytautas Magnus University.

researchers to learn about and actively engage in methodological innovations, and the data mapping attitudinal and behavioural changes in Europe's social, political and moral climate is used for identifying challenges and finding solutions to them.

THE NEED FOR AND PURPOSE OF THE RI

The necessity to address socio-economic, demographic and geopolitical challenges is what makes ESS so important in Lithuania. Global and domestic issues such as social exclusion, distrust in institutions, citizens' disengagement in public governance, backlashes against gender equality, digitalisation, climate change and energy challenges are identified through the analysis of questions in recurrent and rotating modules. The ESS data allows to measure and interpret European people's views cross-nationally and over time. Researchers, students, policymakers, journalists, business representatives and other interested parties can all access and use the survey data.

ACTIVITIES AND SERVICES OF THE RI

The ESS RI aims to provide freely accessible high-quality data on changes in European societies and to promote cross-national comparative research. Key activities include data collection, open access and dissemination processes, the development of training resources and consultations on the use of the ESS data, the development of methodological studies and application of innovations together with methodological training, and cooperation with international partners in projects. One of the priority areas in the ESS ERIC Strategic Plan (2024–2029) is to increase the visibility and impact of the ESS in public policy.

INTERNATIONAL COOPERATION OF THE RI

Lithuania is actively fostering international cooperation as a member of ESS ERIC. Lithuania is institutionally represented on the ESS General Assembly. Research findings are presented at international conferences, and best practices for ESS implementation are exchanged at publicity events. Lithuanian representatives invite foreign specialists for methodological training, take part in international working groups and collaborate with foreign colleagues to develop joint publications and projects. The move to self-completion data collection mode is promoting close international collaboration and experience sharing on methodological matters.

RI link (URL)	https://www.europeansocialsurvey.org/about/country-information/lithuania/lithuanian
Representing authority	Vytautas Magnus University
Participating bodies	–
By readiness to participate in international RI activities	Established
Planned membership in international RI	ESS ERIC (full member)
International RI link (URL)	www.europeansocialsurvey.org
By location and organisation	Institutional
By phase of development	Operating

3.6.2. RI for Survey of Health, Ageing and Retirement in Europe (SHARE Lietuva)

SHARE is a longitudinal survey carried out in 27 European countries and Israel to understand the health, economic situation, well-being and other aspects of life of older people (50+). Lithuania has been participating in the survey since 2015 and has collected three waves of data. The survey in Lithuania is coordinated by a consortium of four institutions (Vilnius University, Kaunas University of Technology, Lithuanian Social Science Centre and Vytautas Magnus University). SHARE survey data is not only valuable from a scientific perspective, but can also contribute to public policy analysis, understanding the impact of policy decisions and evidence-based policy decision-making.

THE NEED FOR AND PURPOSE OF THE RI

Ageing is one of today's most prominent trends, and the EU's Ageing Report (2024) predicts that by 2070, Lithuania will have the highest economic dependency ratio of older people in the EU. These drastic changes are not only a major challenge for social security or health care systems, but will also lead to fundamental changes in the structure of society. Understanding and monitoring the situation is essential to address the

Public use image. Source – Vilnius University.

challenges of ageing, which is why SHARE data are so important. This covers a wide range of ageing-related factors and processes, and allows for in-depth analysis and comparisons between countries. The main objective of SHARE Lietuva is to collect data and make it available to researchers in Lithuania and around the world, to ensure the use of SHARE data in public policymaking and to facilitate the application of these data to other societal needs.

ACTIVITIES AND SERVICES OF THE RI

Coordinating national and international RI initiatives and making sure SHARE data is collected in Lithuania to maintain good data quality are two of SHARE Lietuva's primary responsibilities. For researchers in our country, SHARE Lietuva arranges training and consulting to improve their skills and guarantee efficient data use. By offering data-driven analysis, suggestions and tracking the effects of policy actions, SHARE Lietuva is dedicated to advancing the use of SHARE data in public policymaking. Lastly, SHARE Lietuva concentrates on informing stakeholders and the public about the outcomes the infrastructure has produced.

INTERNATIONAL COOPERATION OF THE RI

SHARE Lietuva actively participates in the international SHARE-ERIC network, which includes representatives of research institutions from 27 European countries and Israel. The international coordination of SHARE-ERIC is currently carried out by the SHARE Berlin Institute, and the quality of the research is ensured by a scientific oversight board composed of renowned European and North American scientists. In addition, SHARE Lietuva has established close links with other SHARE country teams in the region. Currently, SHARE Lietuva institutions are co-leaders of research projects with partners from Latvia, Estonia and Sweden. In addition, SHARE Lietuva participates in the organisation of the periodic international SHARE Baltic Sea Region Conference, which aims to bring together Baltic and Nordic researchers from a variety of disciplines with an interest in ageing.

RI link (URL)	https://www.fsf.vu.lt/mokslas/share
Representing authority	Vilnius University
Participating bodies	Kaunas University of Technology, Lithuanian Centre for Social Sciences, Vytautas Magnus University
By readiness to participate in international RI activities	Mature
Planned membership in international RI	SHARE-ERIC
International RI link (URL)	https://share-eric.eu/
By location and organisation	Joint
By phase of development	Operating

3.6.3. RI for Fertility and Family Survey (GGP LT)

The RI for Fertility and Family Survey (GGP LT) collects, manages and reports data on fertility and family demographic processes, their determinants and consequences. GGP LT carries out research on issues related to families, their well-being and fertility. The RI contributes to the development of evidence-based public policy in Lithuania. GGP LT promotes the internationalisation and competitiveness of social sciences in Lithuania.

THE NEED FOR AND PURPOSE OF THE RI

GGP LT aims to contribute to addressing Lithuania's current demographic challenges related to low birth rates and family change. These have crucial implications for the future and require an effective policy response. This requires detailed demographic data collected using a unique methodology. GGP LT data and research provide a comprehensive analysis of family formation, childbearing, parent-child relationships, family well-being and family crises. The results of the RI contribute to the development of data-driven, evidence-based interventions in family, gender, youth and ageing policies. GGP LT contributes to the strategic goals set out in Lithuania 2050, promotes the international competitiveness of Lithuania's demography and other social sciences, and opens up perspectives for innovative interdisciplinary and cross-cutting research.

Public use image. Source – Vytautas Magnus University.

ACTIVITIES AND SERVICES OF THE RI

GGP LT collects, compiles and manages data on fertility, family demography, intergenerational and gender relations. The RI conducts a large-sample longitudinal panel survey and provides open-access data available through LiDA and the international GGP data portal.

GGP LT develops intellectual products essential for evidence-based family and population social policy development. It also fosters science policy linkages and disseminates the results of research on family demography to the public.

The RI's activities promote the growth of scientific competences and international networking.

INTERNATIONAL COOPERATION OF THE RI

GGP LT is part of the GGP, which is an international RI with 24 countries participating. It is an established RI, included in the ESFRI Roadmap, and offers unique growth opportunities for national RI. Lithuania is institutionally represented on the GGP Consortium Board. Being part of an international RI ensures that the country's research meets the highest international standards.

GGP LT's cooperation with international partners expands opportunities for knowledge exchange and interdisciplinary projects, and enhances the visibility of Lithuanian social sciences worldwide. By actively participating in shaping the international GGP agenda, GGP LT develops new research methodologies and conducts joint research.

RI link (URL)	www.ggp.lt
Representing authority	Vytautas Magnus University
Participating bodies	Lithuanian Social Science Centre, Centre for Strategic Analysis of the State, State Data Agency
By readiness to participate in international RI activities	Mature
Planned membership in international RI	GGP
International RI link (URL)	https://www.ggp-i.org/
By location and organisation	Joint
By phase of development	Operating

3.6.4. Lithuanian Data Archive for Humanities and Social Sciences (LiDA)

LiDA is a digital infrastructure for the collection, preservation and dissemination of SSH research data and other resources. Listed in the Lithuanian RI Roadmap since 2011, LiDA provides access to data from a wide range of research institutions and the public sector. LiDA is a partner of CESSDA-ERIC and is seeking full

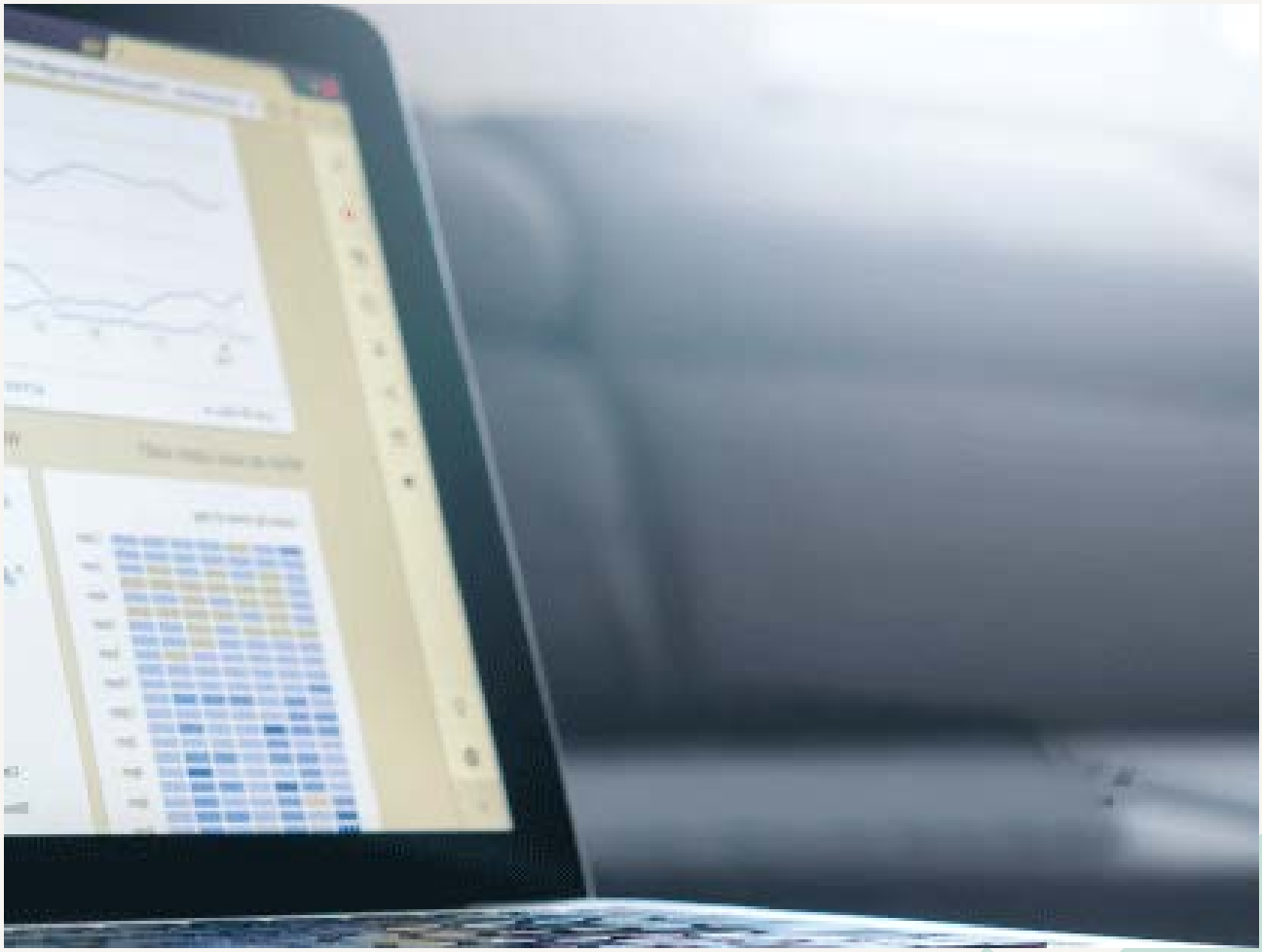
membership. The data catalogue contains more than 600 bilingually documented resources widely used by SSH researchers, the public sector and students.

THE NEED FOR AND PURPOSE OF THE RI

LiDA is an important open-access SSH data infrastructure in Lithuania, promoting a sustainable culture of data archiving, access and reuse. It enables comparative and interdisciplinary research, increases the visibility and competitiveness of Lithuanian researchers internationally and contributes to evidence-based policymaking. By providing access to data, LiDA helps researchers and public sector practitioners to address pressing social issues such as the impact of COVID-19 or climate change.

ACTIVITIES AND SERVICES OF THE RI

LiDA provides services related to the acquisition, long-term storage and dissemination of data, using international documentation standards to ensure that data and other resources comply with FAIR principles. To promote the reuse of data, LiDA provides training for scientists, researchers and public sector staff to make effective use of empirical data. In addition, LiDA actively collaborates with national and international partners implementing the latest data curation standards.



Public use image. Source – Kaunas University of Technology.

INTERNATIONAL COOPERATION OF THE RI

LiDA cooperates with CESSDA-ERIC and its members across Europe. CESSDA-ERIC aims to build an integrated social science data infrastructure to support high-quality research. To strengthen Lithuania's SSH research links with the international research community, LiDA participates in joint projects, organises training workshops and develops Lithuanian versions of data documentation and curation standards..

RI link (URL)	https://lida.dataverse.lt
Representing authority	Kaunas University of Technology
Participating bodies	–
By readiness to participate in international RI activities	Mature
Planned membership in international RI	CESSDA-ERIC
International RI link (URL)	www.cessda.eu
By location and organisation	Institutional
By phase of development	Operating

3.6.5. RI for the Lithuanian Longitudinal Social Survey Research Infrastructure (LIST)

The Lithuanian Longitudinal Social Survey Research Infrastructure (LIST) is the first continuous population survey in Lithuania designed to collect long-term data on public attitudes, values and behaviour. LIST will provide valuable insights into the evolution of society over time and focuses on key contemporary challenges such as climate change, demographic change and technological developments. This infrastructure will contribute to data-driven public policymaking, help policymakers and researchers to make informed decisions, and enhance the internationalisation of social sciences.

THE NEED FOR AND PURPOSE OF THE RI

LIST is designed to fill the gap in repeated survey data needed to analyse the social, economic and cultural development of Lithuania. Existing data sources are mostly one-off surveys, making it impossible to conclude long-term trends or causal relationships. LIST aims to provide replicable data to understand public opinion and behaviour in the long term, to support evidence-based public policy and to assess policy effectiveness. Infrastructure contributes to addressing key challenges such as climate change, technological progress and national security threats.

ACTIVITIES AND SERVICES OF THE RI

LIST will carry out repeated panel surveys with the same respondents on a regular basis. Data will be collected quarterly, covering important topics such as trust in institutions, civic engagement, climate change and evaluation of public policy. Each wave of the survey may have irregularly added question modules to meet the evolving needs

Public use image. Source – generated by artificial intelligence.

of government, academia and the public. The data collected will be made publicly available in the Lithuanian Humanities and Social Sciences Data Archive (LiDA), enabling both national and international researchers to conduct in-depth analyses of public attitudes and behaviours.

International Cooperation of the RI

LIST will seek to establish itself as an active participant in the international research community, particularly in the context of panel research infrastructures. In the development of the infrastructure methodology, LIST has actively collaborated with renowned partners such as the GESIS Panel in Germany and LISS in the Netherlands, ensuring the highest standards of research conduct. LIST will also seek to create new opportunities for Lithuania

to participate in international research consortia, with a focus on comparative research addressing socio-economic, cultural and technological challenges of pan-European interest. The personalised data in LIST will be made available to all interested users through LiDA, thus contributing to international cooperation, a deeper understanding of social trends and Lithuania's engagement in the European Research Area.

RI link (URL)	–
Representing authority	Vilnius University
Participating bodies	Kaunas University of Technology, Vytautas Magnus University, Government Strategic Analysis Centre, State Data Agency
By readiness to participate in international RI activities	Mature
Planned membership in international RI	–
International RI link (URL)	–
By location and organisation	Joint
By phase of development	Starting operation

3.6.6. Lithuanian Folklore Archive Database (LTA TI/LFA IR)

The origins of the Lithuanian Folklore Archive Research Infrastructure (LTA TI) date back to 1935, when an institution of the same name was established in Kaunas to collect, systematise and research folklore. Since 2007, the LTA TI has provided access to hundreds of thousands of digitised Lithuanian folklore works, including manuscripts, audio recordings and photographs. It is one of the largest and oldest folklore archives in the world. The data is available on various digital platforms and portals, and the LTA TI is continuously improving its databases and expanding its international links.

THE NEED FOR AND PURPOSE OF THE RI

The aim of the LTA TI is to contribute to quality research on the nation's cultural heritage, to ensure the preservation of folklore material and to increase its international relevance. LTA TI addresses the problem of access to reliable Lithuanian folklore and other cultural resources, and aims to promote academic development, innovation and cooperation, and to provide research opportunities for those interested in the preservation of cultural and political memory and cultural heritage.

ACTIVITIES AND SERVICES OF THE RI

In addition to the databases, the LTA TI includes a digitisation laboratory and repositories. Manuscripts, audio and video recordings, photographs and negatives are digitised. LTA TI's databases are easily accessible to local users and foreign researchers, and highly qualified specialists are constantly updating and expanding the resources available.

Public use image. Source –Institute of Lithuanian Literature and Folklore.

In addition, LTA TI actively participates in state-funded projects and contributes to the development of standards and practices in folklore research. The LTA also produces and publishes e-books, organises training for researchers and promotes data exchange with other institutions. Future plans include expanding digital capacity, introducing data analysis tools and strengthening international cooperation.

INTERNATIONAL COOPERATION OF THE RI

The LTA TI cooperates with research infrastructures abroad, including archives of the Nordic and Baltic tradition, and seeks international recognition. Links with DARIAH ERIC, a European research infrastructure focusing on the digitisation of cultural heritage, are sought. Such partnerships would provide access to advanced technologies, help expand datasets and promote the long-term sustainability and visibility of LTA TI.

The LTA TI also seeks to participate in international research programmes by promoting interdisciplinary projects and collaborating with other folklore research institutions. This would not only increase the visibility of the LTA TI, but also contribute to the development of international folklore and cultural heritage research. Membership of international research initiatives, such as DARIAH ERIC, could enhance the efficiency of LTA TI's activities by involving more researchers and developing new digital technologies, ensuring continued growth and preservation in a changing digital world.

RI link (URL)	www.tautosakos-rankrastynas.lt
Representing authority	Institute of Lithuanian Literature and Folklore
Participating bodies	–
By readiness to participate in international RI activities	Potential
Planned membership in international RI	DARIAH ERIC
International RI link (URL)	www.dariah.eu
By location and organisation	Institutional
By phase of development	Operating

3.6.7. RI for Electoral Democracy Monitoring (MEDem LT)

The Research Infrastructure for Monitoring Electoral Democracy (MEDem LT) is designed to coordinate and integrate activities related to electoral democracy research in Lithuania and internationally. Building on more than ten years of research experience, MEDem LT aims to increase the internationalisation of electoral democracy research by participating in the European Monitoring Electoral Democracy (MEDem) research infrastructure. Membership of this infrastructure will allow Lithuania to pool and link international sources of data on democratic performance, to conduct higher quality comparative research on electoral democracy. It will be able to develop standards and tools for data collection and analysis, and to contribute to a better understanding of, and response to, the challenges of contemporary liberal democracies.

THE NEED FOR AND PURPOSE OF THE RI

Liberal democracy is facing a crisis due to declining trust in institutions, populism, disinformation, technological innovation and other challenges. In Lithuania, as in other countries of the EU, these challenges are exacerbated by external security threats. The MEDem LT infrastructure is essential for a deeper understanding of these challenges for liberal democracy and for finding solutions to them. MEDem LT's objective is to participate in the international MEDem infrastructure to conduct comprehensive, continuous, innovative, interdisciplinary and internationally comparable monitoring of electoral democracy, to inform the public and decision makers, and to contribute to improving the quality of democratic practices.

Image source – Exhibition of the Centre for Civil Education, Office of the President of the Republic of Lithuania, Robertas Dačkus.

ACTIVITIES AND SERVICES OF THE RI

The activities of MEDem LT include research on voter behaviour and attitudes, parties, candidates, the parliamentary process, public space and political campaigns, as well as informing the public and strengthening of democratic practices. Several large-scale studies are foreseen for the period 2025–2030, including post-election surveys, interviews with voters, analysis of political campaigns, monitoring the implementation of electoral promises, analysis of the votes of members of parliament and more. Researchers taking part in the infrastructure will have the opportunity to improve their methodological skills and to consult with their colleagues abroad. MEDem LT will also develop the voter assistance tool manobalsas.lt, provide expert commentary to the media, develop open datasets and provide recommendations to policymakers.

INTERNATIONAL COOPERATION OF THE RI

MEDem LT aims to actively participate in the international research community on electoral democracy, as only international research can help to better understand and address the challenges of contemporary democracy. Participation in the European MEDem research infrastructure will allow Lithuanian researchers to contribute to the development and use of harmonised international data with high potential, and to carry out large-scale research comparing democratic processes in different countries. Additionally, it will provide Lithuanian electoral

democracy scholars – including their younger colleagues – with the chance to work with academics from other countries, enhance their expertise through specialised training, and obtain the required expert guidance. All of this will increase Lithuania's capacity for research and innovation as well as its competitiveness.

RI link (URL)	http://www.lnes.tspmi.vu.lt
Representing authority	Vilnius University
Participating bodies	Kaunas University of Technology, Vytautas Magnus University
By readiness to participate in international RI activities	Mature
Planned membership in international RI	MEDem
International RI link (URL)	https://www.medem.eu
By location and organisation	Joint
By phase of development	Operating

3.6.8. Common Language Resources and Technology Infrastructure Network (CLARIN-LT)

The Common Language Resources and Technology Infrastructure Network (CLARIN-LT) is a digital resources and language technologies infrastructure that provides Lithuanian and European researchers with access to language resources, analysis tools and long-term data storage options. CLARIN-LT operates as part of the CLARIN ERIC European Research Infrastructure, which supports the development of the social sciences and the humanities by providing access to digital language data and tools in a variety of languages.

THE NEED FOR AND PURPOSE OF THE RI

The CLARIN-LT infrastructure is important for Lithuanian science, especially for researchers in HSS, for whom language resources are a key source of data and an object of research. It is also relevant to computer science by contributing to the development of language technology tools, AI systems and other applications that facilitate human-computer interaction. CLARIN-LT provides access to a common platform for the efficient collection and management of large amounts of digital text, audio and video data used in a wide range of scientific fields. This infrastructure is essential to support the ever-growing demand for research and technology.

ACTIVITIES AND SERVICES OF THE RI

CLARIN-LT provides services for the collection of language resources, their availability and access to language analysis tools.

Membership of CLARIN ERIC provides Lithuanian researchers with access to European language resources such as corpora, audio, video and textual data and dictionaries, among other language resources which are publicly available through a common European infrastructure. The CLARIN-LT consortium also supports the development of new language resources, the enhancement of existing ones, the compliance of data quality with FAIR principles, the development of language technologies, interdisciplinary and international cooperation.

Public use image. Source – Vytautas Magnus University.

INTERNATIONAL COOPERATION OF THE RI

CLARIN-LT is integrated into the international CLARIN ERIC infrastructure, which connects more than 26 countries and provides access to more than 1.2 million digital resources in different languages. Participation in this infrastructure allows Lithuanian researchers and institutions to share data with the international community. CLARIN-LT representatives participate in the governing bodies of the international infrastructure, ensure the integration of Lithuanian language resources in the European platform and promote the implementation of best practice solutions.

RI link (URL)	http://clarin-lt.lt/
Representing authority	Vytautas Magnus University
Participating bodies	Vilnius University, Kaunas University of Technology, Mykolas Romeris University, Klaipėda University, Baltic Institute of Advanced Technology
By readiness to participate in international RI activities	Established
Planned membership in international RI	CLARIN ERIC (full member)
International RI link (URL)	https://www.clarin.eu/
By location and organisation	Joint
By phase of development	Operating

ANNEXES

Annex 1

Composition of the Commission for Research Infrastructures

Item No	Full name	Position in the RI Commission	Institution having delegated to the RI Commission[1]	Position in the institution(s)
1.	Petras Rimantas Venskutonis	Chair	LMT	Professor, Faculty of Chemical Technology, Kaunas University of Technology
2.	Laima Taparauskienė	Deputy Chair	ŠMSM	Director of the Department of Studies, Science and Technology, Ministry of Education, Science and Sport of the Republic of Lithuania
3.	Liutauras Kraniauskas	Member	LMT	Head of the Centre for the Study of Social Change, Faculty of Social Sciences and Humanities, Klaipėda University, Member of the Humanities and Social Sciences Committee of the Research Council of Lithuania
4.	Aurelijus Leipus	Member	EIM	Advisor to the Innovation Policy Group, Ministry of the Economy and Innovation of the Republic of Lithuania
5.	Vaiva Lesauskaitė	Member	LURK	Vice-Rector for Science, Lithuanian University of Health Sciences, Chairperson of the Scientific Committee of the Conference of Rectors of Lithuanian Universities
6.	Artūras Malysis	Member	ŠMSM	Senior Specialist, Science Division, Department of Studies, Science and Technology, Ministry of Education, Science and Sport of the Republic of Lithuania
7.	Justas Nugaras	Member	ŠMSM	Deputy Minister of Education, Science and Sport of the Republic of Lithuania
8.	Saulius Olencevičius	Member	LRPK	Advisor to the President of the Republic of Lithuania
9.	Sigitas Rimkevičius	Member	VMTIDK	Deputy Director, Lithuanian Energy Institute
10.	Virginijus Šikšnys	Member	LMT	Professor, Institute of Biotechnology, Life Sciences Centre, Vilnius University, Member of the Science and Studies Policy Committee of the Research Council of Lithuania
11.	Daiva Žaromskytė-Rastenė	Member	LRVK	Head of the Strategic Management Group of the Office of the Government of the Republic of Lithuania

[1] See 'Abbreviations' section for explanations-

Annex 2

Evolution of the Lithuanian Research Infrastructures Roadmap

	Acronym, abbreviation or nickname of National RI	Title	Connection between national and international RIs	Year of issue (design) of the Roadmap			
				2011	2015	(2020)	2024
DATA, COMPUTING AND DIGITAL RESEARCH	Litgrid-HPC	Lithuanian High-Performance Computing Network	EGI[1] PRACE ERIC[4] CERN[4] EuroHPC[3]	•	•	•	•
	QUARTIC	Cyber Threat Resilience Research Infrastructure	GÉANT[4]				•
ENERGY							
ENVIRONMENT	ACTRIS	Aerosol, Clouds and Trace Gases Research Infrastructure	ACTRIS ERIC[4]			•	
	AEROINFRA	Aerobiology Research Infrastructure	EUFAR[4] EARLINET-ASOS[4]	•	•	•	•
	AGBC	Centre for Plant Genetics and Biotechnologies	NPPN[3]		•		
	BioDatCom Centre	Biodiversity and Geodiversity Data Centre	CETAF DiSSCO[4]				•
	CLIMAGRO LT	Climate-Smart Regenerative and Precision Agriculture Research Infrastructure	AnaEE-ERIC[4]				•
	FOREST 4.0	Centre of Excellence for Advanced Forestry	ICOS ERIC[4] ILTER / eLTER RI[4] LifeWatch ERIC[4] Emphasis[4]				•
	INECOM	Research Infrastructure for Ecological Metabolomics	EMBRC ERIC[4]	•	•		
	NEMUNIUS-RI	Baltic Sea Division of the International Centre for Advanced Studies on River-Sea Systems	LifeWatch ERIC[4]			•	

	Acronym, abbreviation or nickname of National RI	Title	Connection between national and international RIs	Year of issue (design) of the Roadmap			
				2011	2015	(2020)	2024
HEALTH AND FOOD	CossyBio	Centre for Computational, Structural and Systems Biology	EMBL[1] EMBO/EMBC INSTRUCT ERIC[1]	•	•		•
	EBRAINS-LT	European Neuroscience Research Infrastructure in Lithuania	EBRAINS[4]				•
	HBRC (formerly Biobank-LT)	Human Biological Resources Centre	BBMRI-ERIC[1]	•	•	•	•
	MEDWAN	Research Infrastructure for Biomedical Data Collection, Standardisation and Analysis	„BrainIT“[4] EATRIS ERIC[4] BBMRI ERIC[4]	•	•		
	PhenoPlant	Plant Phenotyping Infrastructure for Sustainable Production of Functional Food	EMPHASIS[4]				•
	REIA	Research Infrastructure for Experimental Animals	INFRAFRONTIER ERIC[4]	•	•		
	RILAD	Experimental Animal Research Infrastructure for Disease Modelling	INFRAFRONTIER ERIC[4]				•
PHYSICAL SCIENCES AND ENGINEERING	AChePha	Centre for Applied Chemistry and Biopharmaceuticals (cluster)			•		
	REFRESH	Research Infrastructure for Functional Materials for Sustainable Energy, Environment and Health	CERIC ERIC[4]				•
	Lazerių MTI	High Intensity and Wide Wavelength Range Ultrashort Pulse Lasers for National and International Access RI	ELI ERIC[1] Laserlab-Europe[3]	•	•	•	•
	INNOCHEM	Centre for Innovative Chemistry	CERIC ERIC[4] EMMC[4] ELLIS[4] AMi2030[4]		•	•	•
	LDFK	Lithuanian Particle Physics Consortium	CERN[1]				•
	MECHATRONIKA	Research Infrastructure for Mechatronics			•		

	Acronym, abbreviation or nickname of National RI	Title	Connection between national and international RIs	Year of issue (design) of the Roadmap			
				2011	2015	(2020)	2024
PHYSICAL SCIENCES AND ENGINEERING	MNAC	Micro-, Nanotechnologies and Analysis Open Access Centre	EURONANOLAB[4]		•	•	•
	PTC	Semiconductor Technology Centre		•	•	•	
	SPECTROVERSUM	Centre for Spectroscopic Characterisation of Materials and Electronic/Molecular Processes		•	•	•	
	VU MAO	Vilnius University Molėtai Astronomical Observatory	EUROPLANET[3] WET[3] WEAVE[3]	•	•	•	•
	ULTRATEST	Centre for Non-Destructive Ultrasonic Testing, Measurement and Diagnostics		•	•	•	
HUMANITIES AND SOCIAL SCIENCES	ARUODAI (formerly PITI Aruodai)	HSS Research Infrastructure 'Aruodai'	DARIAH ERIC[4] ENA[4]	•	•	•	
	CLARIN-LT (formerly E-Lingua)	Common Language Resources and Technology Infrastructure Network	CLARIN ERIC[1]	•	•	•	•
	ESS LT	RI for European Social Survey	ESS ERIC[1]		•	•	•
	GGP LT	RI for Fertility and Family Survey	GGP[4]			•	•
	LiDA	Lithuanian Data Archive for Social Sciences and Humanities	CESSDA ERIC[2]	•	•		•
	LIST	Lithuanian Longitudinal Social Survey RI					•
	LTA TR / LFA RI	Lithuanian Folklore Archive's Database	DARIAH ERIC[4]				•
	MEDem LT	Monitoring Electoral Democracy RI	MEDem[4]			•	•
	SHARE Lietuva (formerly HUMRE)	RI for the Survey of Health, Ageing and Retirement in Europe	SHARE-ERIC[2]		•	•	•

[1] RIs that have joined international RIs as full or associate members by a decision of the Seimas of the Republic of Lithuania or the Government of the Republic of Lithuania
[2] RIs in the process of joining an international RI (status as of October 2024)
[3] RIs belonging to an inter-institutional (non-national) international RI consortium
[4] RIs intending to join an international or inter-institutional RI (according to the last Roadmap in which this RI was included)

Annex 3

Chronology of National Research Infrastructures' (RIs) Involvement in International RIs

Name of the national RI	Acronym	Acronym of international RI	Year of		
			the start of activity in the international RI		
				of the decision of the Seimas or Government to join the international RI	
					of the admission to the internatio-nal RI
RI for Digital Resources and Language Technologies	CLARIN-LT	CLARIN ERIC	2008	2014	2014
RI for European Social Survey	EST LT	ESS ERIC	2008	2013	2013
Centre for Computational, Structural and Systems Biology	CossyBio	EMBL, EMBO / EMBC	2014	2019	2020
			2017	2020	2020
Lithuanian Particle Physics Consortium	LDFK	CERN	1993	2017	2018[1]
Lithuanian High-Performance Computing Network	LitGrid-HPC	EGI	2018	2022[2]	2023
High Intensity and Wide Wavelength Range Ultrashort Pulse Lasers for National and International Access RI	Lazerių MTI	ELI ERIC	2016	2020	2021
Human Biological Resources Centre (RI)	HBRC	BBMRI ERIC	2019	2020	2023
Lithuanian Humanities and Social Sciences Data Archive	LiDA	CESSDA-ERIC	2008	2024	–[3]
RI for the Survey of Health, Ageing and Retirement in Europe	SHARE Lietuva	SHARE-ERIC	2014	2024	–[3]

[1] Associate Membership.
[2] Order of the Minister of Education, Science and Sport of the Republic of Lithuania.
[3] The admission procedures are ongoing during the preparation of the Roadmap.

Annex 4

Thematic Areas of Lithuanian Research Infrastructures (RIs), RI Maturity Status and Participating Institutions

Item No	Abbreviation of the Lithuanian RI	Thematic area[1]	Status by maturity[2]	Representing authority	Participating institutions
1.	Litgrid-HPC	DKST	Established	VU	
2.	QUARTIC	DKST	Potential	KTU	
3.	REFRESH	FIM	Mature	KTU	
4.	BioDatCom Centre	Apl	Mature	GTC	
5.	CLIMAGRO LT	Apl	Mature	Slėnis „Nemunas“	VDU, LAMMC, LSMU
6.	FOREST 4.0	Apl	Potential	VDU	LAMMC
7.	CossyBio	SvM	Established	VU	LSMU, NVI
8.	EBRAINS-LT	SvM	Mature	LSMU	KTU, VDU, LSMUL KK, LSMU KL
9.	PhenoPlant	SvM	Potential	LAMMC	VDU
10.	RILAD	SvM	Potential	VU	LSMU, IMC
11.	HBRC	SvM	Established	NVI	VUL SK, VU, IMC, LSMU, LSMUL KK
12.	Lazerių MTI	FIM	Established	VU	FTMC
13.	INNOCHEM	FIM	Mature	FTMC	VU
14.	LDFK	FIM	Established	VU	KTU, LSMU, LEI
15.	MNAC	FIM	Mature	KTU	
16.	VU MAO	FIM	Mature	VU	
17.	CLARIN-LT	SH	Established	VDU	VU, KTU, MRU, KU, BPTI
18.	GGP LT	SH	Mature	VDU	LSMC, STRATA,VDA
19.	LiDA	SH	Mature	KTU	
20.	LIST	SH	Mature	VU	KTU, VDU, STRATA, VDA
21.	LTA TR / LFA RI	SH	Potential	LLTI	
22.	MEDem LT	SH	Mature	VU	VDU, KTU
23.	SHARE Lietuva	SH	Mature	VU	KTU, LSMC, VDU
24.	ESS LT	SH	Established	VDU	

[1] See ‘Abbreviations’ section for definitions.
[2] Lithuania’s position in the 2024 Lithuanian RI rankings in terms of readiness to participate in international RI activities.

Annex 5

Costs for the Development of the Lithuanian Research Infrastructures Roadmap 2024

Roadmap preparation works	Price in thousands, EUR
Preparation of the legal environment for the evaluation process of applications for inclusion of RIs in the Roadmap (seven-member working group)	1.5
Preparation of the first and second parts of the Roadmap (eleven-member working group)	8.5
Two public events – discussions to discuss the Lithuanian RI ecosystem and the Roadmap project	1.9
Threshold expert evaluation / threshold assessment of applications (panel of eight experts)	2.8
Detailed expert evaluation / comprehensive assessment of applications (panel of 25 experts)	12.0
Editing and layout of the publication	1.3
Total	28.0

During the layout work of the publication, on November 19, 2024, national RI SHARE Lithuania (Survey of Health, Ageing and Retirement in Europe – Lithuania) was accepted into the international RI SHARE-ERIC (Survey of Health, Ageing and Retirement in Europe – European Research Infrastructure Consortium).

Responsibility for the use of photographs, the results produced by artificial intelligence, as well as the related risks and their management, lies with the infrastructure entities.

Lithuanian Research Infrastructures Roadmap 2024. Vilnius: Research Council of Lithuania.

ISBN 978-609-462-262-5 (pdf)

The publication consists of three main parts. The first part provides an overview of the development, significance, and classification of Lithuania's research infrastructures (RIs). It introduces their diversity and highlights their strategic importance to the advancement of the national research and experimental development (R&D) system. The second part describes the RI ecosystem, structured around six thematic areas. It explores development opportunities, identifies key gaps, and outlines the main challenges facing each area. The third part focuses on national RIs, which were classified according to their level of preparedness to participate in international RI activities during an expert evaluation process. This publication serves as a national strategic planning document, offering recommendations for policy development, investment planning, and the enhancement of international cooperation.

Publisher
RESEARCH COUNCIL OF LITHUANIA
Gedimino Ave. 3, LT-01103 Vilnius
Tel. +370 670 32 435
info@lmt.lt
https://lmt.lrv.lt/en/

Cover Design, Style and Layout
Publishing House "Kriventa"
V. Pietario St. 5-3, LT-03122 Vilnius
Tel. +370 682 47 899
kriventa@kriventa.lt
www.kriventa.lt

RCL

Research Council of Lithuania