RMTMORI

RESEARCH INFRASTRUCTURE PROJECT

TOWARDS THE REINFORCEMENT OF RESEARCH INFRASTRUCTURES IN THE UPPER RHINE REGION:

MAPPING OF RESEARCH INFRASTRUCTURES

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Project Report of the INTERREG V Project
"RMTMO RI – Strengthening of Research Infrastructures
in the Upper Rhine Metropolitan Region"

EFRE – Europäischer Fonds für regionale Entwicklung
FEDER – Fonds européen de développement régional
„Der Oberrhein wächst zusammen, mit jedem Projekt."
„Dépasser les frontières : projet après projet"

Content

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1. Introduction

Research Infrastructures (RIs) represent nowadays a strategic issue on the scientific and territorial levels (European, national and regional). Considering this, one of the top priorities of the Trinational Metropolitan Region Upper Rhine in its "2020 Strategy" is the implementation of an RI in the trinational area, from which the INTERREG V Upper Rhine proposal "RMTMO RI - Reinforcement of the RIs in the Upper Rhine region" was developed. The aim of this project is to provide a database of RIs and platforms in the Upper Rhine region (Alsace, Western Baden-Wurttemberg, Southern Rhineland-Palatinate and North-western Switzerland) as well as a strategy for the implementation of a RI in the region.

This document was written by the members of the Working Group "Science" of the project « RMTMO RI »[1] in the framework of its mission of inventorying and analyzing the conditions and needs for the implementation of a cross-border research Infrastructure (RI) in the trinational Upper Rhine region. The objective of this document is to offer a global overview of the RIs' landscape in the Upper Rhine Valley, and aims to bring preliminary answers to mapping requests from different university and territorial institutions.

The inventory presented in this document in form of a mapping, first defines the concept of RI basing itself on the European and national definitions. Then, RIs are listed in all scientific domains registered on the respective existing national roadmaps (the newest of them published in 2017, the collection of data was made in mid-2017) that have an entry point on the trinational area. The last part of this document finally sums up the opportunities and further developments that will need to be tackled in the framework of the project.

[1] This project is co-financed by the European Regional Development Fund (ERDF) under the INTERREG V Upper Rhine programme.

2. Definitions and concepts of infrastructure

The following section will focus on the definition of a research infrastructure on the European and national levels. It will also provide a general overview of the RIs in the respective geographical areas and institutions.

2.1. Research infrastructures in Europe

2.1.1. The vision of the European Commission

The European Commission defines research infrastructures (Ri) in its European Charter for Access to RIs[2] and in the framework of the '*European Strategy Forum on Research Infrastructures*' (ESFRI[3]), as facilities, resources or services used by the scientific community for research and innovation, including the main equipment or all instruments, collections, archives, scientific data or other tools essential to achieve excellence in research and innovation.
These infrastructures may be 'single site', 'virtual' or 'distributed', depending on the location of their units.

The distributed RI (according to ESFRI) consists of a central hub to which national nodes are connected. The RI should:

- have a specific name, a legal status and governance with clear responsibilities, including appropriate international and external consultative bodies;
- have a legal coordination role around the centre hub;
- have common public access and an optimal access point unique to users;
- define measurable and appropriate key performance indicators (*KPI*) responding to the excellence of services and sustainability of actions;
- have a human resources policy justifying the skills necessary for the central hub to function correctly, to users' satisfaction, also covering hiring, equal opportunities and training;
- define a joint investment strategy intended to strengthen the RI by means of nodes and common/shared facilities.

These characteristics mean that a distributed RI differs from a coordinated network. The nodes making up the RI should only be partially absorbed by the RI and must keep their national and institutional programmes. However, the capacity and quantity of resources dedicated to the RI must be clearly identified and coordinated by the central hub, according to the rules put in place for example by the consortium or the Executive Board (CODIR) for CELPHEDIA[4]. The central hub should represent a truly international organisation able to function at a high level of efficiency and mediation in different scientific cultures.

A distributed RI should allocate optimal staff capability and coordinating power to display:

- a high level of integration of national nodes;
- added value compared to a cooperative network system.

[2] https://ec.europa.eu/research/infrastructures/pdf/2016_charterforaccessto-ris.pdf
[3] The European Strategy Forum on Research Infrastructures (ESFRI) is a strategic instrument of the European Commission that aims the development of the scientific integration of Europe and strengthening of its international outreach. http://www.esfri.eu/sites/default/files/docs/ESFRI_Roadmap_2018_Public_Guide_f.pdf
[4] CELPHEDIA is a network of 15 centres spread over the whole of France, to be closer to users. This distributed operational RI (Research Infrastructure) brings together a critical mass of expertise and skills unique in Europe, in the fields of creation, functional exploration, archiving and distribution of animal models, needed for fundamental research and preclinical approaches.

Access refers to authorised and legitimate admission, managed by an access policy to the RI's resources and services, with clear and precise communication without discrimination, whether physical, distant or virtual, for use of the RI's resources and services. RIs should offer an access protocol for users allowing effective and efficient access. Users should recognise the contribution of the RI in their research project in any communication and are encouraged to put forward the RI's scientists involved as co-authors. Access should be accompanied by a regulatory framework covering intellectual property, data protection, confidentiality and responsibility.

RIs should have a data management policy and ensure that data are correctly preserved, archived for a reasonable period and are available for revision and reuse, with an agreement between the RI and users about how these data are reused.

RIs are encouraged to offer training courses in their fields of activity and allow their users to benefit from them.

Each RI should offer detailed and transparent information in a single place, about the RI itself, its services, the access policy and procedures, and its data management policy. If applicable, information combining costs, expenses, contractual obligations, health, safety & environment rules, and rights in terms of intellectual property should even appear on the equipment made available.

2.1.2. The League of European Research Universities (LERU): recommendations and golden rules

Since access to medium-size RIs does not appear to be very well organised, the LERU is suggesting measures contributing to the European Open Science agenda:

1. Develop finance mechanisms to make RIs more viable.
2. Encourage cross-border cooperation to invest in new RIs and avoid duplication.
3. Strengthen and extend the connection of the network of European infrastructures.
4. Implement principles of excellence describing the basic operating rules for RIs, with information and policy transparency, by integrating them firmly in existing structures and by means of operational and scientific indicators certifying the excellence of these RIs:
    a. The RI must follow the RI access charter published by the European Commission and implement a FAIR policy (*Findable, Accessible, Interoperable and Reusable*) for data generated with public funds. The aim is to improve the return on investment by reusing data and promoting interoperability of results between disciplines.
    b. Supply recent, complete and verifiable information online about the RI, its scope, governance, access policy and services offered to users. The metadata on facilities and services should be accessible in a standardised way for searching effectively and creating automated catalogues.
    c. The RI must be part of a non-profitmaking organisation that can be held financially and operationally responsible.
    d. The operational and scientific excellence of the RI is highlighted by key indicators, including regular assessments by an independent consultative committee, users and stakeholders, as well as a report of scientific production generated by the centres.
5. The LERU suggests drawing up a checklist to verify that an RI is following these excellence principles and how it implements them.

Scientific assessment in 4 areas:

1. Scientific excellence
2. Pan-European relevance
3. Socio-economic impact
4. IT requirements

Assessment of implementation in 8 areas:

1. Partner commitment
2. User access policy
3. Preparatory work
4. Schedule
5. Governance and management
6. Human resources policy
7. Finance
8. Risks

All the assessments must meet the following 4 principles: independence, impartiality, objectivity, accuracy.

2.1.3. Research infrastructures in Horizon 2020 (H2020)[5]

RIs are within the major challenges of the 8th Framework programme "*Horizon 2020"* of the European Union. **Horizon 2020 is divided in three main pillars**: Scientific excellence (the H2020 dedicated calls for RIs are in this pillar), Industrial leadership and Societal challenges.

RIs are defined in Horizon 2020 as facilities, resources and services used by researchers to conduct their work and promote innovation in their own scientific fields.[6]
If appropriate, they can be used for education or to support other public policies, such as health, safety, environmental protection and presence abroad.
RIs comprise:

- remarkable scientific equipment – or sets of instruments;
- cognitive resources such as collections, archives and scientific libraries;
- virtual infrastructures, such as databases, computer systems and communication networks;
- as well as any other infrastructure or unique type of observation network essential to enable their user scientists to conduct their research and innovation work is an ideal framework of excellence.

Integration and economic development will be emphasised, as much through their use by the private sector as by the innovation they energise with their high technology needs. Great attention will also be given to the international dimension of their impact in terms of attractiveness of talents and partnerships around equipment projects in developing countries.
The synergies with the sources of finance from Structural Funds will be sought to ensure coherent development of RIs, while also ensuring that conditions for granting cohesion funds are met: smart specialisation, support to innovative SMEs, recourse to financial engineering, link with specific regional policies or coordinated as *Regional Partner Facilities*.

The objectives of the Horizon 2020 programme aim to develop outstanding European RIs for 2020 and beyond, to promote their innovation potential and their human resources. The development of new world-class RIs will be the focus of EU's concerns, particularly by supporting the creation, construction, legal formation and efficient operation of research infrastructures. In particular, this development will involve major large-scale facilities identified by the **ESFRI**, and also other world-class research facilities (distributed or single site, physical and virtual), that will help Europe to meet the major challenges of science, industry and society. This objective will specifically involve instituting European governance of

[5] http://www.horizon2020.gouv.fr/cid72594/les-infrastructures-recherche.html
[6] http://www.horizon2020.gouv.fr/cid72594/les-infrastructures-recherche.html

these infrastructures, such as based on European Consortium of Research Infrastructures (**ERIC**) or any other equivalent European or international structure.
The objective is to open key national research infrastructures to all European researchers, both universities and industrial companies, and to ensure their optimum use. Financial aid will be provided to support, in particular, cross-border and virtual access of researchers, as well as the quality of services supplied by the infrastructures.

The aim is to make best use of the potential of existing facilities in terms of technological innovations and operational performance. H2020 will aim to facilitate interest groups, exchange of best practices and staff exchanges between facilities and with industries using RIs.

The main conditions for taking part in H2020 RI calls are:
- to federate at least 3 outstanding and independent entities from 3 different countries.
- to promote a multi-user access policy, especially with industrial companies.
- to offer an after-sales consultancy and professional development service.
- to implement management of acquired data and manage its associated protection.
- to drive prior training and expertise.
- to think in terms of annual budget and complete costs systems.

To enhance the potential for innovation, among other things the funding will aim to:

- establish R&D partnerships companies supplying services and components, to enhance the capabilities of the European Union in cutting-edge fields;
- stimulate the use of RIs by industry, for example experimental test facilities or knowledge gathering centres;
- encourage the integration of RIs into local, regional and global innovation ecosystems, for example by supporting industrial liaison offices;
- develop actions intended to make the infrastructures interoperable, particularly information technology and communication systems.

European Union funding will go to training staff that is managing and operating pan-European research infrastructures, as well as to mobility and constructing staff skills.

Horizon 2020 also finances actions as the MERIL-2 project (Mapping of the European Research Infrastructure Landscape) which aims at providing access to a database that stores information about openly accessible research infrastructures (RIs) in Europe, across all scientific domains, including the social sciences and humanities.

2.1.4. The European Science Foundation initiative: MERIL

The MERIL (Mapping of the European Research Infrastructure Landscape) portal provides access to a database that stores information about openly accessible research infrastructures (RIs) in Europe, across all scientific domains, including the social sciences and humanities. The MERIL-2 project MERIL-2 has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654296.

The MERIL database[7] stores information about European RIs that meet MERIL's eligibility criteria (table 1) where an RI is considered to be MERIL-eligible if all answers to questions 1-5 are positive and if at least one statement under 6 (a, b, or c) applies:

[7] https://portal.meril.eu/meril/

Table 1. MERIL eligibility checklist (source: MERIL)

MERIL eligibility checklist	YES	NO
1. Does the RI have a policy of providing access to users outside of the country in which it is located or by which it is coordinated?		
2. Does the RI provide clear access rules (for example application forms, open calls and contact information) and an access point for users on a publicly available web page?		
3. Does the RI provide a website in English (including the access rules)?		
4. Does the RI receive national, regional or European public funding?		
5. Does the RI have an appointed contact or manager responsible for the RI?		
6. The RI is of *more than national relevance* because it…		
a) can provide evidence that it is used by non-national (European or international) users by for example providing the number of non-national users per year		
b) is part of a European or international network		
c) has formal arrangements or agreements with international partners, for example with similar RIs in other countries		

MERIL adopts the following definition of a research infrastructure:
''A European Research Infrastructure is a facility or (virtual) platform that provides the scientific community with resources and services to conduct research in their respective fields. These research infrastructures can be single-sited or distributed or an e-infrastructure, and can be part of a national or international network of facilities, or of interconnected scientific instrument networks.

Furthermore:

- RIs offer recognised, established scientific and technological facilities or services
- RIs permit free access or regulate access through a transparent selection process based on scientific quality and project feasibility
- RIs are managed according to sustainable principles and have a long-term perspective''.

Remarks on the data

The present document has been partially based on data provided by the MERIL-2 project. The MERIL database is being populated on a daily basis as the MERIL project proceeds with data collection for the most accurate presentation of the European RI ecosystem, therefore, the list of RIs presented here might not be exhaustive. As a result, while an effort has been made to present data in the most comprehensive and clear way, the statistics presented here should be considered as indicative and preliminary.

Results

MERIL database query of 945 records, accessed on *20/10/2017*, and queried in terms of the coordinates binding the Upper Rhine Valley region, identifies 19 RIs: 12 single-sited RIs located in the Upper Rhine Valley, 5 distributed and 2 virtual RIs whose coordinating centres are located in the region, and 2 RIs that are nodes of distributed RIs located outside the region (Figure 1).

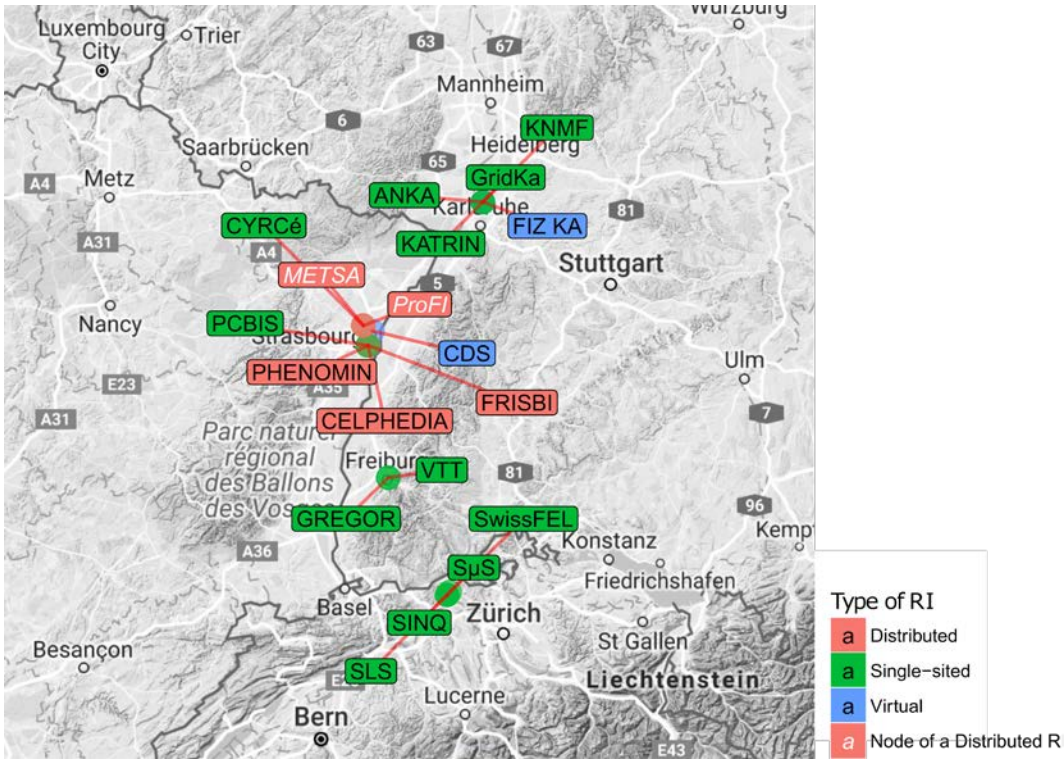

Figure 1. Map of 19 MERIL-indexed RIs distributed across the Upper Rhine Valley.

Table 2. List of Upper Rhine Valley-based RIs (19) indexed in MERIL. RIs are categorized in terms of MERIL-designed RI Category (column 3). See Appendix for the glossary of MERIL RI Categories.

Acronym	Name	RI Category	Location Country
ANKA	Synchrotron Facility ANgstromquelle KArlsruhe	Intense Light Sources	Germany
CDS	Strasbourg Astronomical Data Center	Research Archives,Research Bibliographies,Software Service Facilities,Databases,Data Archives, Data Repositories and Collections	France
CELPHEDIA	Creation, Breeding, Phenotyping, Distribution Archiving of Vertebrate Model Organisms	Animal facilities,Repositories,Cell Culture Facilities,Biomedical Imaging Facilities	France
CYRCé	Cyclotron for Research and Training in Strasbourg	Biomedical Imaging Facilities	France
FIZ KA	FIZ Karlsruhe - Leibniz Institute for Information Infrastructure	Research Bibliographies,Databases,Data Archives, Data Repositories and Collections,Research Data Service Facilities,Repositories	Germany
FRISBI	French Infrastructure for Integrated Structural Biology	Biomedical Imaging Facilities,Cell Culture Facilities,Bio-informatics Facilities,Structural Biology Facilities	France
GREGOR	GREGOR Solar Telescope	Telescopes	Germany

GridKa	Grid Computing Centre Karlsruhe	Distributed Computing Facilities,Complex Data Facilities	Germany
KATRIN	KArlsruhe TRitium Neutrino Experiment	Astro-particle and neutrino detectors and observatories	Germany
KNMF	Karlsruhe Nano Micro Facility	Micro- and Nanotechnology facilities	Germany
METSA	Transmission Electron Microscopy and Atom Probe Network	Micro- and Nanotechnology facilities,Analytical Facilities	France
PCBIS	Platform of Integrative Chemical Biology of Strasbourg	Chemical Libraries and Screening Facilities,Cell Culture Facilities	France
PHENOMIN	French National Infrastructure for Mouse Phenogenomics	Biomedical Imaging Facilities,Animal facilities,Cell Culture Facilities,Repositories	France
ProFI	Proteomics French Infrastructure	Genomic, Transcriptomic, Proteomics and Metabolomics Facilities	France
SINQ	Swiss Spallation Neutron Source	Intense Neutron Sources	Switzerland
SLS	Swiss Light Source	Intense Light Sources	Switzerland
SwissFEL	SwissFEL	High Energy Physics Facilities,Micro- and Nanotechnology facilities,Intense Neutron Sources,Nuclear Research Facilities,Intense Light Sources	Switzerland
SμS	Swiss Muon Source	Intense Neutron Sources	Switzerland
VTT	Vacuum Tower Telescope	Telescopes	Germany

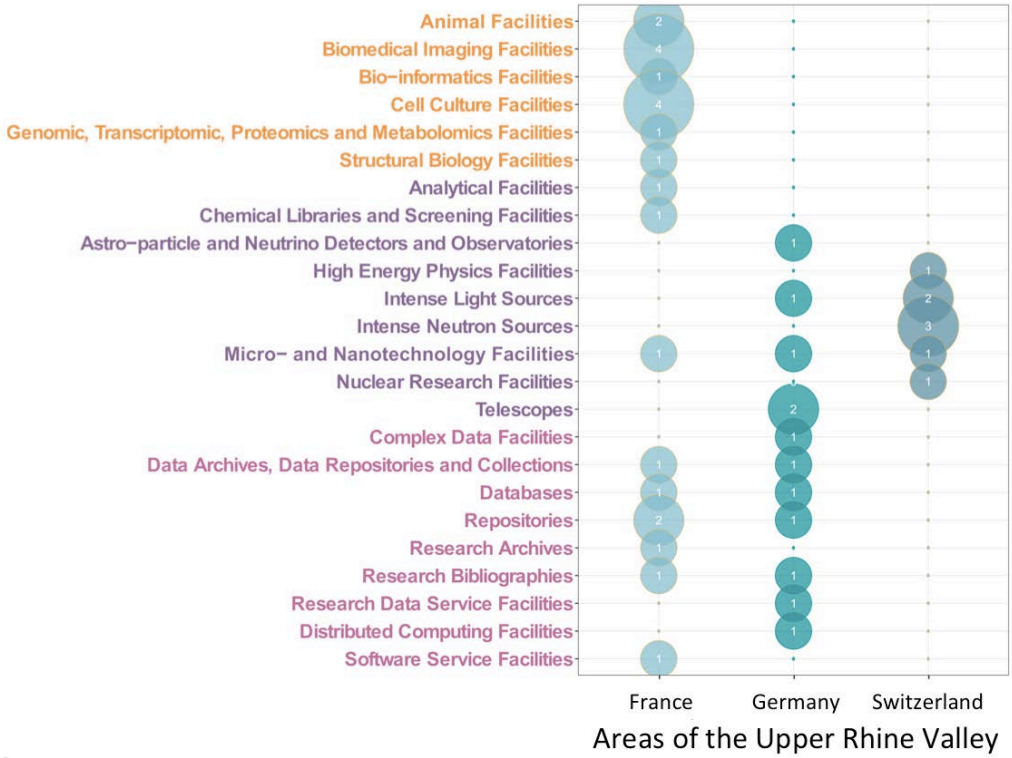

Figure 2. The 43 RI categories of the 19 Upper Rhine Valley-based RIs indexed in MERIL[8]

[8] This figure was presented by the members of MERIL on October 12th 2017.

The RIs indexed by MERIL (figure 2) shows a strong complementarity in the Upper Rhine Valley. Nevertheless we have to take into account that MERIL database is populated on a voluntary basis and thus several RIs may have escaped the current mapping. Moreover, some of the facilities listed do not fully correspond to the definition of an RI according to the WGS members since they have rather the size or the means of a core facility and therefore need to be reconsidered in the framework of the current mapping.

2.2. Research infrastructures in France

2.2.1. Definition of the French Ministry of Higher Education and Research[9]

RIs are facilities, resources and services used by researchers to conduct their work and promote innovation in their own scientific fields. Whether they are 'single site', 'virtual' or 'distributed', these infrastructures enable outstanding research to be conducted and provide a service for one or more scientific communities.
RIs contribute strongly to the effort of training scientists, engineers and technicians that underpin France's global reputation. Hosting foreign researchers and their projects make a particular contribution to this international influence.

The founding principles of research infrastructures are part of a general policy defined by the following objectives:

- to be leader in the construction of a Europe of infrastructures;
- to provide a French presence in major international programmes;
- to serve all the identified issues of society;
- to support the needs of research communities, particularly fundamental research in all areas of knowledge;
- to strengthen partnerships with supplier and user economic sectors.

RIs comprise:

- remarkable scientific equipment – or sets of instruments;
- cognitive resources such as collections, archives and scientific libraries;
- virtual infrastructures, such as databases, computer systems and communication networks;
- as well as any other infrastructure or unique type of observation network essential to enable their user scientists to conduct their research and innovation work is an ideal framework of excellence.

In the future, RIs must be in a position to:

- produce a multi-year budgetary programme and a consolidated budget including full costs;
- make the data produced available, either immediately or after an embargo period appropriate to international practices in the relevant field.

Principles defining a major research infrastructure:

- it must be an organisation having unique characteristics identified as required by the user scientific community to conduct high level research activities.

[9] http://www.horizon2020.gouv.fr/cid72594/les-infrastructures-recherche.html
http://www.ncp.fnrs.be/index.php/appels/infra
http://multimedia.enseignementsup-recherche.gouv.fr/SNIR/index.html

- it must have identified, unified and effective governance, and strategic and scientific steering committees;
- it must be open to any research community wishing to use it, its access based on scientific excellence evaluated by peers, and must therefore have suitable evaluation bodies;
- it can conduct its own research, and/or supply services to one (or more) user communities including organisations from the economic sector.

Unlike the ESFRI roadmap, which presents new infrastructures (each RI lasts 10 years), the French national roadmap presents all infrastructures (new ones and older ones of interest). The main objectives of the Ministry's strategic plan and national strategy (**roadmap**) regarding Research Infrastructures are (updated every 4 years, last update in 2016):

- Opening to the scientific community;
- Managing its own research and provide services;
- Producing a multi-year budgetary programme including a budget integrating full costs;
- Producing, storing and making the data produced available.

2.2.2. In French research organisations

CNRS - French National Centre for Scientific Research[10]

As part of its role and working jointly with its French, European and international partners, the CNRS manages Very Large Research Infrastructures (TGIR) and Research Infrastructures (IR) for the benefit of the whole scientific community. In this way, researchers from all disciplines (astronomy, biology, physics, chemistry, human and social sciences, earth sciences, etc.) have access to the best facilities in the very high level international scientific environment: telescopes, high energy physics accelerators, sources of neutrons and synchrotron radiation, lasers and intense magnetic fields, influence calculation resources, etc.

IRSTEA - National Institute for environmental and agricultural scientific and technical research[11]

Research infrastructures are research instruments open for use by various research organisations. These infrastructures support research teams by providing the tools needed for their work, and also scientific and technical expertise able to give definite visibility to their results.

INSERM - National Institute for Health and medical research[12]

Research infrastructures are inseparable from high level and competitive research. The quality of these infrastructures, in terms of production and responsiveness, is an important factor in their attractiveness for both academic and industrial research teams. Furthermore, not only is the research based on shared platforms/infrastructures comprising cutting edge instruments, but it also contributes to developing and improving methods. The aim of the infrastructures centre created in 2016 at the *Institut Thématique Technologies pour la Santé* (Healthcare Technologies Themed Institute) is to coordinate Inserm's technological platforms and strengthen participation in national research infrastructures.

INRA - National Institute for Agricultural Research[13]

Research infrastructures bring major scientific, technological and organisational issues for agronomic, environmental and food sciences. For this reason INRA is committed to an approach to formalising its

[10] http://www.cnrs.fr/fr/recherche/tgir/presentation.htm
[11] http://www.irstea.fr/la-recherche/les-infrastructures-de-recherche
[12] http://www.inserm.fr/qu-est-ce-que-l-inserm/organigramme/instituts/organisation-de-l-institut-techno/pole-infrastructures-de-l-inserm
[13] https://inra-dam-front-resources-cdn.brainsonic.com/ressources/afile/368466-19bb9-resource-charte-des-infrastructures-de-recherche-inra.pdf

network of research infrastructures, according to an overall consistency plan, based on national and European roadmaps.
A charter lays out the main characteristics expected of an INRA research infrastructure: experimental units and experimental facilities, biological resource centres, collections, observatories, analytical platforms, technological research platforms and any collective entity producing and handling data.
Access to research infrastructures for all INRA research units as well as other organisations involved in public or private research. RIs have recognised collective governance bodies responsible for meeting these principles of openness, economic sustainability and accessibility to the facilities or data produced.
RIs use a unique and transparent system to provide information about the services and facilities that they supply, submission procedures, conditions for use and data management. The RIs and users ensure that RIs are duly cited in output (publication, patent, etc.) to which the RIs contributed.
Charges to be paid to access the services of an RI are determined using clear and explicit rules, interpreted according to the nature of partners using the RI and nature of the services supplied.

CEA - French atomic energy agency[14]
The CEA provides the scientific community numerous research infrastructures in the fields of energy sources, healthcare and life sciences, micro- and nanotechnologies, materials sciences and the universe. These provide better coordination of research, enhanced skills and optimisation of resources.

2.2.3. Important Research infrastructures in France

France is home to several Very Large Research Infrastructures (VLRIs) that pertain to a government strategy. They are national or are subject to international or European partnerships, in particular through their engagement in the roadmap of the European strategy forum (ESFRI). They are major instruments in the networks of industrial and innovation collaboration. There are on the 2016 roadmap 20 VLRIs distributed between the different fields of research.

France also contributes to the funding of following research infrastructures involved in International organizations:

- Nuclear and high-energy physics: CERN-LHC European Organization for Nuclear Research – Large Hadron Collider
- Astronomy and astrophysics: ESO – European Southern Observatory
- Biology and Health:
  - EMBL – European Molecular biology Laboratory
  - EMBC – European Molecular Biology Conference
- Earth system and environmental sciences:
  - CEPMMT - European Centre for medium-Range Weather Forecasts

2.2.4. Carnot label and the Inter Carnot-Fraunhofer programme (PICF)

The Carnot label was created in 2006 for structures that develop research partnerships between research institutions and actors of the socio-economic area, i.e. companies. It aims to enhance the visibility of technological research in France and can be single-site or multisite. This label is awarded for 5 years by the French ministry for Higher Education and research on a proposal by the French national Agency, the latter finances the institutes according to the incomes of the research partnerships contracts. There are in 2017 in France 38 Carnot institutes, 1 of them located in Mulhouse (Materials Institute Carnot Alsace MICA[15]) and the other in Strasbourg (Télécom et société numérique[16]).

[14] http://www.cea.fr/
[15] http://www.carnot-mica.fr/

France and Germany set a common tool for the development of research partnerships via the Inter Carnot – Fraunhofer programme (PICF). The aim of the program is the launch of calls for projects in order to enhance collaborative research and innovative French-German projects between both institutes. The projects aim to reinforce the leadership in industrial research (on the national and international levels), prepare the technology and knowledge transfer towards the industry and create strategic French-German alliances between research institutes of excellence.

2.3. Research infrastructures in Germany

2.3.1. Definition of the German Federal Ministry of Education and Research (BMBF)[17]

Research Infrastructures (RIs) are comprehensive, long-term research resources, such as laboratories, equipment, instruments, collections of materials and databases, or service facilities for the purpose of research in any scientific field, which stand out due to at least national significance in their particular field of science and to a certain longevity (more than ten years, as a rule).

In the past, only large-scale facilities such as particle accelerators or research vessels were classified as Research Infrastructures. Today, the term is used in a broader sense and includes databases, collections and social Research Infrastructures. Distinction is made with respect to smaller infrastructures and facilities in the natural, biological and environmental sciences, engineering and medical science as regards the size of the investment, which should amount to a minimum of 15 million euros. This boundary is waived in other fields of science like the humanities, social sciences and economics.

New forms of Research Infrastructures have been developed as a result of improvements in information and communication technologies. These so-called IT infrastructures (e-infrastructures) include high-performance computers and computer grids which are particularly important for analysing data.

The National roadmap for research infrastructures
In the past, the Federal Ministry of Education and Research (BMBF) has earmarked considerable funds for the implementation of new research infrastructures. The BMBF launched the pilot phase to establish a roadmap for research infrastructures in 2011 in order to continue investing the available resources as efficiently as possible and to be able to plan the realization of new research infrastructures on a long-term basis. The German Roadmap for Research Infrastructures provides input to decision makers on how to distribute resources, which projects could be funded and in what timeframe. It lists the established RI projects which are currently prioritized and those that are still under construction. The 2013 Roadmap, while not providing a funding guarantee for the selected projects, indicated a clear political will of the Ministry to fund them, and the ongoing roadmap process follows a similar aim. In 2015, the German Federal Ministry of Education and Research (BMBF) requested a new National Roadmap document, which is expected to be released in the beginning of 2018.[18]

Definition of Research Infrastructures in the National Roadmap Process
Research Infrastructures for the purposes of the National Roadmap Process are characterized by the following features:

- They are of national importance for research policy.
- They have a long utilization period – generally of at least ten years.
- Access to them is generally open, and their utilization is regulated on the basis of scientific quality standards.

[16] http://www.instituts-carnot.eu/fr/institut-carnot/telecom-societe-numerique
[17] https://www.bmbf.de/de/roadmap-fuer-forschungsinfrastrukturen-541.html
[18] https://www.wissenschaftsrat.de/en/fields-of-activity/research_infrastructures.html

- The cost of establishing and installing the infrastructures is so high that considerable national public funding is necessary, justifying a comprehensive national decision-making process.
- They must have an extensive governance system that is adequate for the relevant task. In cases involving various locations with complementary tasks, they must form a functionally integrated Research Infrastructure with common standards that can be regarded as a single entity.

The core element of the roadmap process is an evaluation of the scientific aspects. This evaluation serves as a basis for setting the BMBF's overall priorities, while also taking the issues of social relevance and financial feasibility into consideration. Important foundations are being laid that exceed the boundaries of individual disciplines. This national roadmap process consists of three steps:

1. Eligibility check of submitted proposals of RI.
2. Independent experts evaluate the proposals on their scientific (scientific potential, utilization, feasibility, significance for Germany) and economic success, as well as their societal relevance.
3. Ministries decide whether to include the proposal in the roadmap. The roadmap is regularly updated, including new evaluation results.

All projects in the various scientific fields and irrespective of any potential host organization are taken into consideration when weighing up the requirement for research infrastructure projects, their respective objectives and quality, along with the costs involved in set-up and operation. A transparent evaluation of the projects, which is equally based on scientific and economic criteria, aims to increase the general acceptance of major research policy decisions at the same time.

In view of the fact that many research infrastructures can only be put into practice on the basis of European or international partnerships, the roadmap process also serves to prepare and support political decision-making as regards the participation in and funding of European and international research infrastructure projects and to facilitate the selection of projects in which Germany is to assume a leading role.

2.3.2. Definition of the German Research Foundation (DFG)[19]

A research infrastructure may be a single location or a group of distributed institutions, which may form part of a national or international network. The term 'research infrastructure' covers many things, from dedicated facilities and analytical services to information infrastructures such as libraries, data repositories, open access repositories and virtual research environments.

The research infrastructure portal "RIsources" [19] (operated by the DFG) contains information about scientific research infrastructures which provide researchers with resources and services for planning and implementing research projects.

The portal "RIsources" includes research infrastructures which:

- offer recognised, established scientific and technological facilities or services;
- permit free access or regulate access through a transparent selection process based on scientific quality and project feasibility;
- are managed according to sustainable principles and have a long-term perspective.

They aim to make more efficient use of existing resources, provide external users with access to the technologies or sources of information they need and offer professional support from the institutions. The portal is under construction and information is continually being added. Registration requests are checked by the DFG on a regular basis.

[19] http://risources.dfg.de/home_en.html

2.3.3. RI in German Research organizations

Leibniz Association[20]

The Leibniz Association connects 88 independent research institutes that address issues of international societal relevance, ranging from the humanities and the social sciences to the natural sciences and engineering. Leibniz Institutes pursue both basic and applied research – often under one roof.

Research infrastructures are central resources which make science possible and open up new questions. With its internal strategy process, the Leibniz Association has highlighted the significance of decentralized as well as medium to small-sized research infrastructures and their work, which do not always find mention in the national and international debate. Information infrastructures, major data-recording projects for social data, panels and cohorts, scientific collections as well as social research infrastructures guarantee innovative science both within and outside of the Leibniz Association.

The Leibniz Roadmap contains concepts for research infrastructures which the Leibniz Association has prioritized in an internal process – with priority going to concepts which require a larger consortium of Leibniz partners and external partners. The selection criteria for the projects were as follows: the enabling of excellent research, social relevance, being of central importance to the scientific landscape, and a user-orientated approach. The concepts also stand out thanks to their innovative character and a clear unique feature. Thus, they further consolidate the profile of the Leibniz Association. The internal process has also contributed to the incorporation of four concepts in the national prioritizing process – the National Roadmap for Research Infrastructures. At the same time, three projects have been newly included in the 2016 update of the ESFRI Roadmap, in which the Leibniz Institutes are involved – in some cases as the project leader. These projects also form a part of the Leibniz Roadmap.

The Leibniz Roadmap for Research Infrastructures represents the establishment of a continuous process. The Roadmap will be regularly assessed and updated. It maps out how the Leibniz Association can sustainably consolidate, and help dynamically shape, the German scientific system, including the Association's own institutes.

Helmholtz Association[21]

The Helmholtz Association is dedicated to pursuing the long-term research goals of state and society as well as maintaining and improving the living conditions of the population. It is **Germany's largest scientific organization** with 18 research centres, which are legally independent bodies working together in **six research fields**: energy, earth and environment, health, key technologies, matter and aeronautics, space and transport. The Helmholtz Association is the only research organization in Germany whose mission is to set up, operate and further develop large research infrastructures, such as particle accelerators, research vessels and aircraft. Its facilities are made available to teams from universities and non-university research institutes both within Germany and abroad.

The Helmholtz Centres have numerous unique research infrastructures at their disposal – from laboratory rooms, experimental stations and computer centres, to research ships for coastal, high-sea and polar experiments, to particle accelerators and reactors for the production of photons, ions and neutrons – that offer an excellent experimental basis for both internal Helmholtz Association research and users from all over the world.

The Helmholtz Association research facilities are exemplary for division of responsibilities within the German scientific system and cooperation of the Helmholtz Association with German and foreign universities and research facilities. Helmholtz Centre general guidelines determine the basic principles within which the university and non-university participation by third parties regarding the utilization of research infrastructures takes place.

Large-scale research infrastructures can be found in all six of the Helmholtz Association research fields. The Helmholtz Association research facilities are as diverse as their research, and many of the technological performance capabilities of the facilities are unique.

[20] https://www.leibniz-gemeinschaft.de/en/infrastructures/leibniz-roadmap-for-research-infrastructures/
[21] https://www.helmholtz.de/en/research_infrastructure/

Development, construction and operation of the scientific large-scale facilities at Helmholtz Centres for an international user community are a core element in the mission of the Helmholtz Association. An important planning basis for development of the research infrastructures is provided by the Helmholtz Roadmap, within which the Helmholtz Association lays out their current planning regarding the scientific large-scale facilities and infrastructures. In 2011, the Helmholtz Association presented for the first time their research-field-overlapping Roadmap for new research infrastructures. In the meantime, an updated version of this roadmap is available since 2015[22].

Fraunhofer-Gesellschaft[23]

The Fraunhofer-Gesellschaft conducts applied research for private as well as public enterprises and for the general benefit of the public (health and environment, security and protection, communication and knowledge, transportation and mobility, energy and resources, production and supply of services). It currently operates a total of 67 institutes and research units and is the largest organization for applied research in Europe.

The National Photonics Labs (NPL) will be the first research infrastructure to be implemented under the aegis of Fraunhofer. The leading responsible institution is the Fraunhofer Institute for Applied Optics and Precision Engineering (IOF) in Jena. The implementation phase is planned for the years 2018 to 2023.

Max-Planck-Gesellschaft[24]

The Max Planck Society (MPG) is an independent, non-profit research organization named after the world-famous physicist Max Planck. The Max Planck Society maintains a total of 83 institutes and research facilities – not only in Germany, but also abroad. Primarily, the MPG performs basic research in the natural sciences, life sciences, humanities and social sciences, thus complementing research projects at universities.

The institutes of the Max Planck Society participate very successfully in international and interdisciplinary infrastructure projects. The attached table of RIs (22) in Germany list the infrastructures that have been included in the BMBF roadmap with the participation of the MPG (and some of them are also on the current ESFRI roadmap).

2.3.4. Important Research infrastructures in Germany

Germany is home to several research infrastructures of global significance in physics, earth science, climate research and the humanities:

DESY - Deutsches Elektronen-Synchrotron[25]

Founded in 1959, Deutsches Elektronen-Synchrotron (DESY) is an internationally renowned centre of fundamental research and one of the world's leading institutions investigating the structure of matter. DESY is a member of the Helmholtz Association and is supported by public funds.

DKRZ - German Climate Computing Centre[26]

The German Climate Computing Centre (DKRZ) provides high-performance computing services tailored to climate research. Its mission is to install and operate a high-performance computer system for basic and applied research in earth system sciences and to provide the associated services such as optimization, parallelization, data management and data visualization.

[22] https://www.helmholtz.de/fileadmin/user_upload/publikationen/Helmholtz_Roadmap_2015_web_korr_150921.pdf
[23] https://www.fraunhofer.de/en/about-fraunhofer/profile-structure.html
[24] https://www.mpg.de/en
[25] http://www.desy.de/index_eng.html
[26] https://www.dkrz.de/dkrz-en?set_language=en

Polarstern[27]
The research vessel Polarstern was first commissioned in 1982. Since then it has completed more than 250 expeditions to the Arctic and Antarctic. Specially designed for working in polar seas, Polarstern is currently one of the most sophisticated polar research and supply vessels in the world.

FLASH - Free-Electron Laser in Hamburg[28]
FLASH at DESY in Hamburg was the first laser worldwide in the ultraviolet and soft X-ray range. Starting as a user facility in 2005, it was recently enhanced with a second light generating beamline. As the first FEL serving two beamlines at the same time, it has thus retained its globally unique status.

Germany also contributes to the funding of joint international research infrastructures, such as:

- the European Space Agency (ESA), Paris, France
  http://www.esa.int/ESA
- the European Southern Observatory (ESO), Garching, Germany
  http://www.eso.org/public/
- the European Organization for Nuclear Research (CERN) in Geneva, Switzerland
  http://home.cern

2.4. Research infrastructures in Switzerland

2.4.1. Definition of the Swiss State Secretary for Education, Research and Innovation (SBFI)

In Switzerland, the definition of RI is based on the MERIL project (Mapping of the European Research Infrastructure Landscape scape) and makes an additional distinction between RI with a direct research purpose and those which serve the coordination of scientific areas. The operational definition of RI, which is applied within the framework of the Swiss Roadmap, is based on RI's current concept at European level, but explicitly excludes editing projects in the humanities.

The Swiss roadmap for research infrastructures[29]
This roadmap is based on the following definition of "research infrastructure":

- The infrastructure makes a key contribution to the development of a particular field of knowledge or research (scientific added value);
- The infrastructure is widely used by researchers in Switzerland (national significance);
- The infrastructure is in principle open to national and international research communities (open access);
- The infrastructure may be situated at a single location or organized in a network with several locations with a centralized management structure.

Characteristically, RIs in Switzerland are publicly or privately owned and are structured / implemented in a medium- to long-term manner (usually more than 10 years). They therefore generally exceed the planning horizon of an individual ERI Dispatch.

The Swiss 2015 roadmap serves as the basis of national funding decisions by providing prioritized RI projects. However, it does not guarantee financial support to these listed projects. Since Institutions of

[27] https://www.awi.de/en/expedition/ships/polarstern.html
[28] https://flash.desy.de
[29] https://www.sbfi.admin.ch/sbfi/en/home/topics/research-and-innovation-in-switzerland/swiss-roadmap-for-research-infrastructures.html

Higher Education (universities) determine scientific future priorities and are primarily responsible for RI funding, whereas the Confederation contributes additional federal support to projects of national relevance, they are closely involved in the roadmap process and can play a highly influential role. For example, applicants of the roadmap call have to prove the co- funding of their project by their university. Submitted RI proposals are evaluated through a two-step process.

In the first evaluation round the Swiss national Science Foundation (SNFS) groups applications in three priority categories, according to their scientific added value, use and accessibility, feasibility, financing and their significance for Switzerland. Twenty-three projects from all fields, especially MINT programs, succeeded to the second step, received an in-depth review and implementation plans were developed. Besides this list of potential new RI projects, the roadmap contains an inventory of already existing RI. The roadmap states clearly, that it does not grant actual funding to certain projects. This rather depends on the de facto available federal funds.

2.4.2. Important Research infrastructures in Switzerland

FORS – Swiss Centre of Expertise in the Social Sciences[30]
As a national center of expertise, FORS serves as a liaison office between Swiss and international research in the social sciences. FORS grants Swiss researchers access to all its resources and to all the latest findings in the social sciences. By the same token, FORS is the first point of contact for non-Swiss researchers interested in Swiss social sciences data and analyses. FORS is involved in a variety of international projects, several of which are part of the Swiss Roadmap for Research Infrastructures.

Paul Scherrer Institute[31]
The Paul Scherrer Institute operates three large research facilities: a third-generation synchrotron X-ray source (SLS), the only continuous spallation neutron source in the world (SINQ) and the world's most powerful continuous-beam µSR facility (SµS). SINQ and SµS are driven by the high-intensity proton accelerator (HIPA) which also serves the particle physics program with pions, muons and ultracold neutrons.

SBP – The Swiss Biobanking Platform[32]
SBP is the national coordination platform for human and non-human biobanks. It aims to respond to the increasing requests from biomedical researchers regarding quality and the interconnectedness of biobanks for research purposes.

SCTO - Swiss Clinical Trial Organisation[33]
The Swiss Clinical Trial Organisation (SCTO) is the central cooperation platform for patient-oriented clinical research in Switzerland. Its primary objective is to attractively and competitively position Swiss clinical research in the international competition with respect to innovation and quality.
The SCTO is a joint initiative of the Swiss National Science Foundation (SNSF) and the Swiss Academy of Medical Sciences (SAMS). The SCTO is an independent association and part of the Swiss roadmap.

[30] http://forscenter.ch/en/about-us-2/philosophy/research-infrastructures/

[31] https://www.psi.ch/science/large-research-facilities
[32] http://www.swissbiobanking.ch
[33] https://www.scto.ch/en/organisation.html

SIB - Swiss Institute for Bioinformatics[34]

The Swiss Institute of Bioinformatics provides world-class core bioinformatics resources to the national and international life science research community in fields such genomics, proteomics and systems biology. It provides services like the bioinformatics research infrastructure, leveraging government funding. It also plays a federating role, linking the Swiss bioinformatics community, promoting and coordinating research and education with funding from the universities, partners and research grants.

Switzerland is an active member of eight international research organisations that conduct experiments and use world leading research facilities in their fields of expertise.

Research organisations in astronomy, high-energy and particle physics and nuclear fusion:

- CERN, the European Organisation for Nuclear Research (http://home.cern)
- ESRF, European Synchrotron Radiation Facility (www.esrf.eu)
- ILL, Institute Max von Laue - Paul Langevin (www.ill.eu)
- ITER / Fusion for Energy (www.iter.org)
- ESO, the European Southern Observatory (www.eso.org/public/)
- European XFEL (www.xfel.eu)
- ESS, European Spallation Source (https://europeanspallationsource.se)

Research organisation in molecular biology:

- EMBL, European Molecular Biology Laboratory (www.embl.de/index.php)

The definition of a research infrastructure is a complex task since it needs to be broad enough in order to cover a maximum of kinds of big equipment or research sites, but it also needs to be precise enough to differentiate it from other kinds of facilities. The definition set by the EU is nowadays used as a common standard since it considers these characteristics. Moreover, the member states tend to follow the ESFRI roadmap agenda and base their strategy on it. It is therefore recommended to use the definition of the EU as a basis for the project. Part 2 also shows that the RI landscape and the topic “RI” concerns manifold stakeholders which participate in their construction and implementation.

[34] https://www.sib.swiss

3. Mapping of Research Infrastructures in the Upper Rhine region

3.1. Methodology

The following mapping of RIs is based on revised data from the MERIL database (bottom-up approach) as well as on the ESFRI and the national roadmaps (top-down approach) collected by the members of the working group science. The mapping focuses on the RIs with "entry-points" in the Upper Rhine region, this means that either some of them have a coordinating node in the Upper Rhine region, or convened a partnership. The aim of the mapping is to have an overview on the RI landscape in the trinational region in all scientific domains based on those two main sources; the result of it is a list of 31 RIs. The following section presents a short analysis of the complete list; the latter is available on appendix 2.

3.2. RIs on the national roadmaps with an entry-point in the Upper Rhine region (all domains)

Figure 3 shows the thematic distribution of the RIs, listed by the WGS members, having an entry-point in the Upper Rhine region, according to ESFRI's scientific domains. The majority of RIs listed are thematically linked with the Health and food domain (45%). The other domains are respectively under 20%. No RI is linked to the "Energy" ESFRI domain.

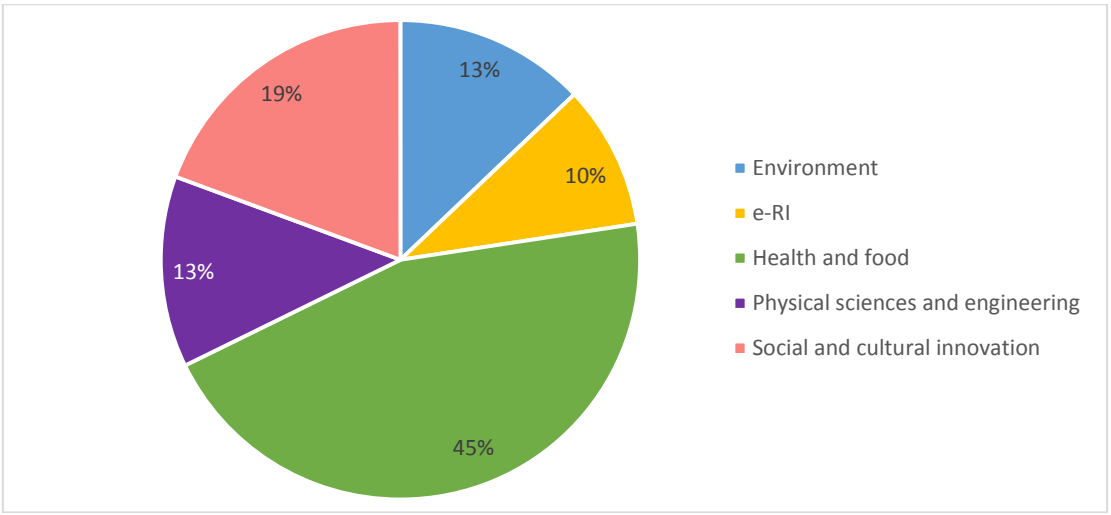

Figure 3. Thematic distribution of RIs having an entry-point in the Upper Rhine region (sources: national and European roadmaps, MERIL database)

Out of the 31 RIs, 13 have already a European dimension since they are registered on the ESFRI roadmap as a project and/or a landmark.
The three following specificities are noticeable:

- the ESFRI RI "DARIAH" is common to two national RIs: one located in Strasbourg, the other one in Karlsruhe
- the French RI "Collex-Persée" has an entry-point at the national library in Strasbourg, while the other ones are linked with the university of Strasbourg
- the ESFRI RI "ESS" is the only on-site RI located outside of the Upper Rheine region (Lund, Sweden).

Figure 4 shows the distribution of RIs and thematic domains according to the different sites of the Upper Rhine region. Strasbourg is the site with the most entry-points (18) that cover all domains (except "Energy" as mentioned before and the only one with "e-RI") followed by Basel, Karlsruhe and Freiburg. Strasbourg has a strong focus on the ESFRI domain "Health and Food", followed by Basel and Freiburg (the only domain for the latter). RIs in "Physical sciences and engineering" and "Environment" can only be found in Karlsruhe and Strasbourg.

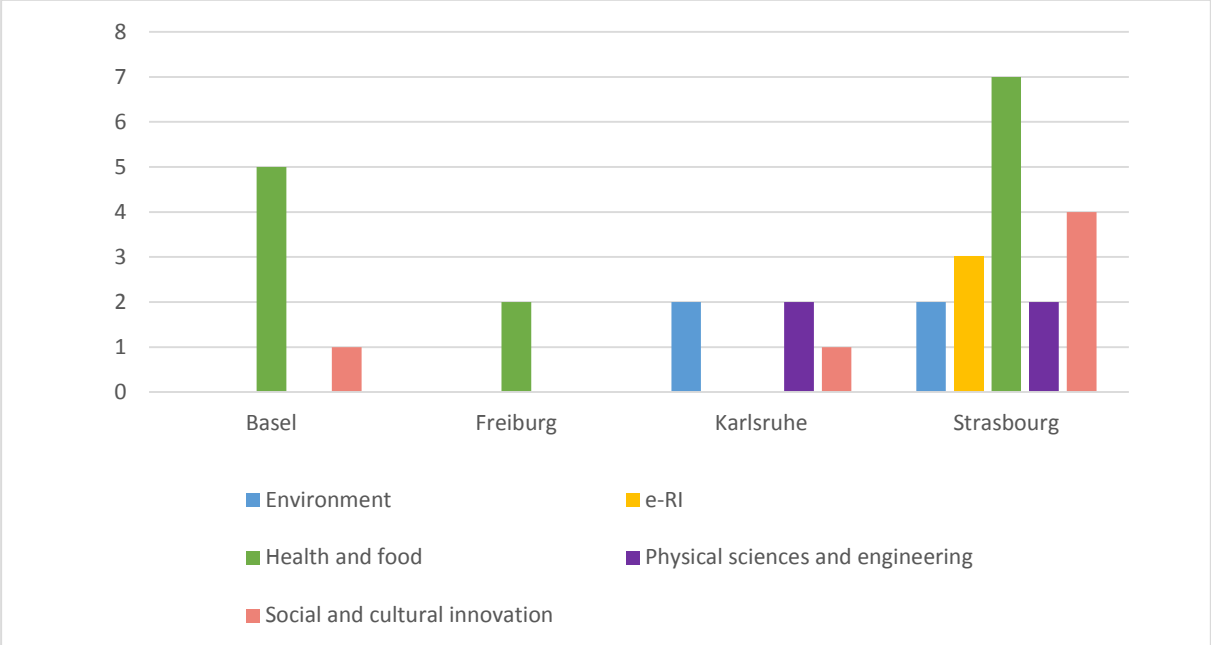

Figure 4. Distribution of RIs according to the sites they are linked with (sources: national and European roadmaps, MERIL database)

According to the sources used, the RI landscape in the Upper Rhine is richly diversified and are more or less already developed on the European level. There is currently no RI domain common to all sites listed, which shows that they are rather complementary to each other.

4. Conclusion

RIs can be defined based on a set of common criteria since they meet the same general definition in Europe and the trinational region. Indeed, RIs are 'single site', 'virtual' or 'distributed' facilities, bringing together resources (main facilities or set of instruments, collections, archives, scientific data, etc.) and services provided for the scientific community with the aim of conducting outstanding research and encouraging innovation.

These RIs must be national leaders to be integrated into the construction of a European infrastructure, to support the needs of academic researchers and strengthen partnerships with suppliers and users from economic sectors. Measureable and appropriate Key Performance Indicators (KPI) should be carefully defined to evaluate the excellence of services and sustainability of actions. RIs must have an identified and effective governance with appropriate external consultative bodies, and must have a defined data policy ultimately to make available the data produced (Open Science), with a well-defined secure storage.

At national level, RIs have additional specific characteristics: they must be able to produce a multi-year budgetary programme and a consolidated budget including full costs. Indeed in all European-defined RI, the EC only supports so far 20% of overall activities at best.

At European level, emphasis is placed on:

- governance organised around a central hub able to function at a high level of efficiency and mediation in different scientific cultures,
- a high level of integration of national nodes,
- transparency and details of information (costs, contractual obligations, safety, health & environment, intellectual property) in one place,
- a single, regulated access policy, optimised for users,
- an investment strategy intended to strengthen the RI.

Taking into account the important number of stakeholders in the different countries, it is possible to share a single definition for RIs. Very specific criteria are well defined in relation to a research platform or a research service. The RI can include all these levels, necessarily open nationally or even internationally.

Moreover, as part of the approach for this project, the concept of regional partner RIs (Regional Partner Facility) able to integrate existing RIs (identified in the mapping), even to develop a new RI, revolving around both intelligent specialisations of the regions and coordinated with the policy of the Upper Rhine region, represents a very interesting opportunity. Such an RI would make the Trinational region very attractive and would offer strong support for research within the academic world and for innovative SMEs.

The concept of research platform (or core facility) will also need to be clearly defined in the framework of the "RMTMO RI" project. At a European level, the platform/core facility is technical or a service supplier, but there is no official definition as it is the case for RIs. On the national level in France, a platform is the combination on the same site of facilities and human resources intended to offer a user community high level technological resources. By adopting the IBiSA charter[35], the platform is committed to broad regional and national opening, not only to teams on the site but also outside academic or private experimenters. The recognition of a platform and its specific resources

[35] https://www.ibisa.net/charte.php

(finance, staff) that arise from it, are determined by a general specification note that may be specified depending on the theme of the platform. The platform has a scientific board, comprising users and outside experts, which define the priorities of projects, ensure the quality of services offered and suggest improvements in methods. The human and equipment resources available on the platform are used to train students (placements, PhD students, etc.), engineers and technicians and for scientific and technical leadership programmes and trainings (seminars, workshops, study sessions, etc.). This definition could be used by the RMTMO RI project for the next inventory of research platforms/core facilities in order to define clearly the awaited input, taking into account specific criteria for the database such as those listed in 2.2. of this paper. For example, large core facilities with user access, are located in the Upper Rhine region, but are not on the national roadmap, such as in Karlsruhe the European Zebrafish Resource Center (EZRC), the biology facility and the Karlsruhe Nano Micro Facility (KNMF).

The Upper Rhine region represents with its 49 entry points of RIs a strong territory for RIs in a variety of different domains (as confirmed by the analysis by MERIL), the great part of them being at the intersections of the national and European level. Moreover, their function as a support for the scientific network enhances the scientific dynamism of R&I in the Upper Rhine Valley. The implementation of a trinational RI in the framework of RMTMO RI will need to take into consideration these strengths represented by RIs and opportunities that represent the platforms and networks on the territory, as well as define the perimeter of the future RI in matter of scientific profiles. It may be also of interest to consider the areas directly surrounding the Upper Rhine region like Heidelberg for example, which has a certain number of facilities and organisations of interest such as the EMBL, which are unavoidable in their research fields.

One of the awaited results of the RMTMO RI project is the implementation of an IT-database of Research infrastructures in the trinational region. The definition of a research infrastructure in this context will have to be decided (RIs from the national roadmaps? From other sources? Also research platforms / core facilities?) as well as the information that will be provided in this tool. Therefore, the working group “Science” has identified the following items and criteria that should be taken into consideration for the inventory and the filling in of the database. This listing is available in annex 3.

5. Appendix

Appendix 1 – Glossary of MERIL RI Categories

Biological & Medical Sciences

Agronomy, Forestry, Plant Breeding Centres

Facilities that enable open field and forest experiments to test the impact of management practices and of environmental conditions on soil, crop, and primary production. These include plants and trees ex-situ collections, experimental facilities for controlled crosses and propagation, and population genetics field testing. The facilities are relevant for Biological- and Environmental Sciences.

Animal Facilities

Facilities that provide husbandry of animals and services to the biomedical research community, usually equipped with highly automated systems that provide the best possible conditions for animal reproduction and maintenance.

The main activity is the reproduction and maintenance of animal stocks either of inbred strains or genetically engineered animals, such as transgenic and knockout mouse lines, or even chemically-induced mutants.

Collections of Biological Resources (e.g. Microorganisms, Biobanks and Seed Banks)

Facilities for storage of collections of microorganisms, biological material and the associated data and information facilities for a population or a large subset of a population, maintained under controlled conditions (temperature, humidity, atmosphere, etc.). The biological resources, including microorganisms, human/animal cells, tissue, blood and DNA, seeds of crops, trees and wild plant species, are conserved for their genetic endowment. Databases established on these provide holistic information on each accession with scientific descriptors, ethno-botanical/ zoological/microbiological/medical knowledge, including for the purpose of establishing intellectual property rights and ownership over the biomaterial stored.

Bio-Informatics Facilities

Bioinformatics facilities generate knowledge through computer analysis of biological data. These can consist of the information stored in the genetic code, but also experimental results from various sources, patient statistics, and scientific literature. Research in bioinformatics includes method development for storage, retrieval, and analysis of the data. Bioinformatics is a rapidly developing branch of biology and is highly interdisciplinary, using techniques and concepts from informatics, statistics, mathematics, chemistry, biochemistry, physics, and linguistics. It has many practical applications in different areas of biology and medicine.

Biomedical Imaging Facilities

Facilities which are equipped for visualisation, characterisation, and measurement of biological processes at the cellular and tissue levels in humans and other living systems.

Cell Culture Facilities

Facilities that are equipped to provide robust support for isolation and culture of a variety of cell lines (like mammalian and insect cell lines, mouse and human embryonic stem cells), including serum preparation, feeders, growth factors and mycoplasma testing, this may be on serum-based or serum-free media.

Clinical Research Centres

Facilities that support patient-oriented research, involving a particular person or group of people or using materials from humans. This research can include: studies of mechanisms of human disease; studies of therapies or interventions for disease; clinical trials; studies to develop new technology related to disease.

Environmental Health Research Facilities

Environmental health research addresses all potential hazards caused to a human being or an animal by external physical, chemical, and biological factors, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments. This definition excludes behaviour not related to environment, as well as behaviour related to the social and cultural environment, and genetics. This category includes toxicology and infectious diseases facilities as well as epidemiological study centres.

Genomic, Transcriptomic, Proteomics and Metabolomics Facilities

Multiple sites ranging from single laboratory DNA sequencing and RNA transcript analysis facilities run by biologists for their own department's research to high-throughput facilities aimed at providing a sophisticated service for a broad community of biologists run by informaticians, biologists and engineers.
Proteomics: physical chemistry developments for clinical and biological applications getting access to proteins network linked to the physiological and pathological stated of the cells. This includes nutrigenomics research.

Structural Biology Facilities

Facilities which are equipped for visualisation, characterisation, and measurement of biological processes at the molecular level in humans and other living systems. Main technologies include protein crystallisation, X-ray diffraction, mass spectrometry, DSC.

Systems Biology/Computational Biology Facilities

Laboratories that combine all relevant scientific disciplines and the know-how to integrate experimental data with computational and theoretical approaches with the aim of targeting, understanding and engineering pathways, cells, organs and complete organisms.

Telemedicine Laboratories and E-Health Technologies

E-Health is an emerging concept relating to the use of networked digital ICTs (primarily the Internet) to facilitate the organisation & delivery of health care and services. It encompasses applications for providers and organisations (e.g. for storing, exchanging and using clinical or administrative data, or aiding evidence-based practice) and for citizens and patients (e.g. web-based health information, education, virtual consulting), as well as research applications of e-Health technologies.

Translational Research Centres

Translational Research Centres support the integration of evidence based medicine, social sciences and political sciences with the aim of optimising patient care and preventive measures which may extend beyond healthcare services. This is the process of turning appropriate biological discoveries into drugs and medical devices that can be used in the treatment of patients.

Chemistry and Material Sciences

Analytical Facilities

All facilities where analytical tools are used that are based on one of the following probes or methods: electrons, photons, neutrons, radio frequency, NMR, or analytical chemistry. It does include Surface Science Laboratories dedicated to analysis and characterization of surface and interface phenomena. Different users would come from the scientific domains Chemistry, Earth science, Bio-Medical (including forensic) science and different sensitivities (Analytical Chemistry, electron microscopy laboratories); NMR facilities; surface science laboratories; x-ray diffraction; Electron Microscopy Laboratories, aspects in life sciences, earth, forensics; Surface Science Laboratories.

Chemical Libraries and Screening Facilities

Digital libraries related to chemistry as well as screening facilities.

Intense Light Sources

All facilities that provide access to intense light radiation sources as used for lasers, synchrotrons, Free Electron Lasers. The facilities are relevant to the scientific domains of Physics, Chemistry, Bio-Medical Sciences, Earth and Environmental Sciences, Humanities & Arts, Information Science & Technology; Laser Sources for materials synthesis laboratories; Laser Sources for spectroscopy laboratories; Synchrotron Light Sources and X-Ray Diffraction Facilities.

Intense Neutron Sources

Accelerator-based neutron source facility that provides the intense pulsed neutron beam.

Materials Synthesis or Testing Facilities

All single or multi sited facilities run by engineers and materials scientists to process or test materials with regard to predefined specifications. It includes testing and processing equipment, structural and properties characterization instruments. The facilities are relevant to the scientific domains of Engineering, Materials Sciences, Physics, and Chemistry.

Pilot Plants for Process Testing

Plants where processes in biological or chemical systems, including bioenergy/biorefinery research and food processing research, are tested on a pilot level scale. Biology, Chemistry.

Reference Material Repositories

Facilities providing materials with at least one standardised and fully described property that can be used in measurements e.g. as a standard for calibration of instruments or as reference for measuring other materials.

Earth and Environmental Sciences

Acoustic Monitoring Stations

Non audible very low frequency waves infrasound stations, (volcano meteors monitoring, avalanches, landslides) ; audible frequency stations and hydro acoustic stations (marine mammals, multi-beam, acoustic tomography, echosounders, sodar); high frequency stations (T-phase stations).

Atmospheric Measurement Facilities

Meteorological stations (all physical parameters that can be observed) ; Global Atmospheric Watch (GAW); Airglow; Ionospheric stations (all sky cameras, ionospheric radar); brewers; lidars; chemical compositions, pollution and radionuclides facilities; This includes atmospheric test chambers, used to conduct controlled experiments for climate change research and atmosphere related problems.

Earth Observation Satellites

Including Optical-IR Earth Observation satellites and Radar Earth Observation satellites.

Earth, Ocean, Marine, Freshwater, and Atmosphere Data Centres

Platforms for the exchange of earth, oceanographic, marine, freshwater and atmospheric data and information, and for advisory services in the field of earth, ocean, marine, freshwater and atmospheric data management. National Data Centres, Designated National Agencies for international data exchange and Satellite Data Centres represent the backbone of the data and information infrastructure. National networks are usually put in place to interconnect the data centres of major national institutes. The overall objective is to significantly improve the overview and access to data and data analysis from government and research institutes.

Earthquake Simulation Laboratories

Facilities that are equipped to do computer-assisted earthquake simulation .

Environmental Management Infrastructures

Pilot facilities and experimental infrastructures for management, ecological restoration and environmental mitigation of terrestrial and aquatic ecosystems in natural or degraded conditions (including hydrological and soil management field facilities; decontamination and bioremediation facilities and pilot plants).

Environmental Management Infrastructures

Pilot facilities and experimental infrastructures for management, ecological restoration and environmental mitigation of terrestrial and aquatic ecosystems in natural or degraded conditions (including hydrological and soil management field facilities; decontamination and bioremediation facilities and pilot plants).

Geothermal Research Facilities

Facilities that enable research, development, and demonstration of technologies to advance the use of geothermal energy as a clean, renewable, domestic power source.

In Situ Earth Observatories

Platforms and sensor technologies deployed in situ to collect environmental data (including physical, chemical and biological observations) in support of terrestrial environmental research and management activities. These facilities, including ecological habitat field stations, provide a base for trans-disciplinary research and training, with access to terrestrial field sites for survey and experimental opportunities and often supporting environmental observations and the collection of long-term time series data sets (a.o. on biodiversity).

In Situ Marine/Freshwater Observatories

Platforms and sensor technologies deployed in situ to collect environmental data (including physical, chemical and biological observations) in support of aquatic environmental research and management activities. These facilities, including marine/freshwater research centres, provide a base for trans-disciplinary research and training, with access to marine and freshwater field sites, and equipment (including research vessels that may carry large exchangeable underwater equipment/instruments) for survey and experimental opportunities and often supporting environmental observations and the collection of long-term time series data sets (a.o. on biodiversity).

Typical equipment includes: Buoys; Argo; gliders; autonomous underwater vehicles; remotely operated vehicle (Victor); Tide gauges; deep sea laboratories.
Ship-time for stock assessments, polar supply, naval research, and educational courses and non-academic research are not considered in this context.
NOTE: For this inventory the atmospheric measurement facilities are kept as a separate category. This implies that some marine research centres will also fall under this category if they host an atmospheric measurement site.

Natural History Collections

Facilities that serve as a library of organisms have lived and/or are living on Earth and curation sites for materials relevant for planetary exploration. They contribute to specific research and public education in an easily accessible venue.

Polar and Cryospheric Research Infrastructures

Arctic and Antarctic stations; high altitude and mountain stations; heavy icebreakers; International Partnerships in Ice Core Sciences (IPICS); ANDRILL; Polar Ionospheric stations.

Research Aircraft

Solid Earth Observatories, including Seismological Monitoring Stations

Drilling platforms and sensor technologies deployed to collect solid earth data and material in support of solid earth research and management activities. This includes facilities that collect seismological data to be added to the European Integrated Data Archive (EIDA) and made available to the scientific community.
Integrated Ocean Drilling Programme (IODP) and Integrated Continental Drilling Programme (ICDP); Sediment Coring Archives; VLBI stations.

Engineering & Energy

Aerospace and Aerodynamics Research Facilities

Single-sited facilities providing a controlled wind stream in which objects (aircrafts, vehicles, buildings) are placed in order to measure their aerodynamic properties, using for instance lasers and/or simulate an operation and control during flight/ drive; includes wind tunnels.

Civil Engineering Research Infrastructures

Single-sited, distributed or virtual facilities for the design, construction, testing (including the use of shaking tables) and maintenance of non-military, non-aerospace or non-mechanical large structures, typically including large buildings, transport infrastructures, bridges, dams, tunnels, sewers, plus river, coastal and public health engineering.

Electrical and Optical Engineering Facilities

Single- or multi-sited facilities that offer scientists and engineers access to devices for handling light, utilizing properties of light, and detecting light or access to infrastructure for research and development in the fields of electricity, electronics, and electromagnetism. These infrastructures may either broadly deal with electrical or electronic engineering, or be focused specifically on some of the numerous subtopics, like electronics, electric power, telecommunications, control systems, or other.

Energy Engineering Facilities (non-nuclear)

Combustion, solar, wind, production & distribution, includes, combustion test facilities and associated technologies.

Marine & Maritime Engineering Facilities

Experimental facilities in the fields of hydraulics, geophysical fluid dynamics, ship dynamics and ice engineering research. These include: Basins (both for marine research with waves and/or (tidal) currents and research on inland water issues); multi-directional wave basins; flumes (both for marine research and for research on inland water issues); towing tanks for ship dynamics research; cavitation tunnels; rotation basins for research on coriolis dominated issues; facilities for ice research; other hydraulic facilities. The facilities are relevant for the scientific domains Engineering, Earth and Environmental Sciences, Marine and Polar Sciences

Mechanical Engineering Facilities

Facilities dedicated to manufacturing, assembly and testing of components and systems offering services related to control, integration and realization of products and processes including modelling and simulation tools. Processing technology, road-transport vehicle development and testing are included.

Humanities & Arts

Collections

Sets of often unique objects and items of different types collected usually to be exhibited. Collections normally include a collecting policy for new acquisitions, so only objects and items in certain categories and of a certain quality are accepted into the collection. Objects in a collection are normally catalogued, traditionally in a card index, but nowadays this is being replaced by computerized database also for physical collections. These type of RIs are particularly relevant for the humanities, which often deal with the study of unique artifacts, but they can be relevant for other domains, such as social sciences, life and environmental sciences.

PHYSICAL

- Museums
- Galleries
- Analogue audio/visual/multimedia collections
- Archaeology, Anthropology and Ethnology Collections
- Arts & Art History Collections
- Music and Instrument Collections
- Datasets (e.g. analogue audio/visual/multimedia datasets)

DIGITAL

- Archaeology, Anthropology and Ethnology Collections
- Arts & Art History Collections
- Digitised Manuscript Collections
- Music and Instrument Collections
- Virtual museums
- Virtual galleries
- Datasets

Repositories

Locations for storage of often unique objects and items of different nature, in general for preservation purposes. Repositories not only have the function to store objects and items but they also guarantee access for future retrieval and study. This type of RI in its general definition is relevant to all scientific domains (for instance as far as physical or virtual facility for the deposit of academic publications such as academic journal articles are concerned); however, some humanities disciplines strongly rely on specific repositories for its analysis.

PHYSICAL

- Analogue audio/visual/multimedia repositories
- Archaeology, Anthropology and Ethnology Repositories
- Arts & Art History Repositories

DIGITAL

- Data repositories (e.g. digital library)
- Archaeology, Anthropology and Ethnology Repositories
- Arts & Art History Repositories
- Digitised Manuscript Repositories

Databases

Structured sets of data for one or more purposes, usually in digital form. The term database applies to the data and their supporting data structures. The utilisation of databases is spread across all scientific disciplines. Databases are therefore RIs relevant to all scientific domains. Databases in the form of structured meta-data as well as analytical data organised usually within a relational model have been extensively developed as RIs in the Humanities with increasing uptake in all its disciplines.

- Archaeology, Anthropology and Ethnology Databases
- Arts & Art History Databases
- History Databases
- Digitised Manuscript Databases

Conceptual Models

Explicit formalisations that map a concept to its intended semantics. Conceptual models are adopted in every research domain (e.g. economic models, mathematical models). In the humanities, however, some conceptual models have developed into RIs indispensable to structure a certain knowledge domain, such as is the case for thesauri and taxonomies (also very much used in life sciences) which have a long tradition

in supporting analytical efforts especially in linguistics. Increasingly, digital models built around conceptual ontologies and networks are being developed for modelling specific research domain or for cross-referencing purposes in the Humanities.

Research Archives

Accounting normally for organised sets of unpublished and almost always unique historical records, or the physical place they are located, archives contain primary source documents (texts, maps, pictures etc.) in physical but also increasingly digital form (e.g. text archives structured in databases) that have accumulated over the course of an individual or organisation's lifetime. In general, archives consist of records that have been selected for permanent or long-term preservation on grounds of their enduring cultural, historical, or evidentiary value. Archives are thus particularly relevant to the Humanities, chiefly to historians but also to many other Humanities researchers dealing with primary sources of various kinds. A scientific discipline called archival science, dedicated to the study and practice of organising, preserving, and providing access to information and materials in archives, has established itself within the Humanities.

- History Archives
- Literature and Text Archives

Research Libraries

Traditionally, large collections of books, or the place in which the collection is housed. However, the term library has extended its meaning to refer to any collection, including digital sources, resources, and services. The collections can be of print, audio, and visual materials in numerous formats, including maps, prints, documents, microform (microfilm/microfiche), CDs, cassettes, videotapes, DVDs, video games, e-books, audiobooks and many other electronic resources. A research library is a collection of useful material for research use. A library is organised for use and maintained by a public body, an institution, a corporation, or a private individual. In addition to providing materials, libraries also provide the services of librarians who are experts at finding and organising information and at interpreting information needs. Modern libraries are increasingly being redefined as places to get unrestricted access to information in many formats and from many sources. They are extending services beyond the physical walls of a building, by providing material accessible by electronic means, and by providing the assistance of librarians in navigating and analysing tremendous amounts of information with a variety of digital tools. Llibraries are valuable to all scientific domains; however, they are of specific relevance to Humanities research which relies on access to historical and rare collections of unique artefacts (e.g. primary sources such as ancient manuscripts) and other sources to study those artefacts and works (secondary and tertiary sources) usually held within libraries and otherwise hardly accessible. A scientific discipline called library and information science, an interdisciplinary or multidisciplinary field dedicated to the analysis, collection, organisation, classification, manipulation, preservation, retrieval and dissemination of information resources, has established itself at the crossroads between social sciences, humanities and computer sciences. Historically, library science has also included archival science.

Research Bibliographies

Large-scale systematic lists of books and other works such as journal articles, reference and access resources. They can be physical publications (i.e. bound volumes) or digital (indexes and catalogues usually in the form of databases).

They can be generally divided into enumerative bibliography (also called compilative, reference or systematic), which results in an overview of publications in a particular category, and analytical, or critical, bibliography, which studies the production of research material (in the form of books as well as other formats, including recordings, motion pictures, videos, graphic objects, databases, CD-ROMs and websites). As a bibliography can be produced in any field, it could be considered a transversal category; however it is Humanities research especially that has traditionally relied on such tools to systematise its fields of enquiry – spanning centuries of relevant publications for many humanities disciplines – and circumscribe its research domain.

Information Science & Technology

Centralised Computing Facilities

Single-sited facilities with a centralised control that enable high performance computing through supercomputers. These are relevant to all scientific domains.

Communication Networks

Facilities responsible, at national or international levels, for the provision of data communications networks, capacity and services to the research and education community in all scientific domains. The networks typically connect other networks at international, regional or metropolitan level.

Complex Data Facilities

Facilities to store huge and high dimensional data volumes and apply statistical methods to classify or cluster the data in order to extract valuable information. The facilities are relevant to Bio-Medical Sciences; Earth and Environmental Sciences; Physics; Astrophysics; Social Sciences.

Distributed Computing Facilities

Facilities for virtualisation, grid and cloud computing, or capability computing that are loosely coupled, heterogeneous, and geographically dispersed distributed system with non-interactive workloads that involve a large number of files. They federate, share and coordinate distributed resources from different organisations that are not subject to centralized control, using open, general-purpose and in some cases standard protocols and interfaces to deliver non-trivial qualities of service relevant to all scientific domains.

Software Service Facilities

Facilities that provide access to well fabricated software for modelling, simulation, development, control and optimization, including software libraries/ repositories or support services for the implementation of the software, their maintenance and adaptation to new hardware platforms as well consultation regarding proper use of the software as well as training facilities for users. These are relevant to all scientific domains.

Physics, Astronomy, Astrophysics and Mathematics

Astro-Particle and Neutrino Detectors and Observatories

Range of detectors/observatories, using interactions in water or ice for detecting astrophysical neutrinos, interactions in liquid noble gases or solids for searching for dark matter particles, and light emission in the atmosphere for the detection of gamma rays from astrophysical sources.

Centres for Advanced Research in Mathematics

Research Centres hosting researchers and organizing scientific events at a high level. Three different types of centres can be distinguished according to their aim: a) centres organizing high level one week conferences in mathematics or their interface with sciences and industry; b) centres organizing, over three or more months, targeted advanced scientific programmes at doctoral level or on specific research challenges; c) high-level research institutes with few permanent positions and a highly developed visitor's programme. (High level mathematics, interface between mathematics and other sciences).

Centres for Development of Industrial Mathematics

Centres devoted to the development of the interface between mathematics and industry. Their research groups offer a wide range of mathematical expertise and are able to interact with scientists from other disciplines (life sciences, bio-medicine, material sciences, engineering, computer sciences, physics, social sciences, etc.) both in the academic or industrial frameworks. (Industrial mathematics, applied mathematics).

Cross-Disciplinary Centres in Mathematics

Specialised structures devoted to the interaction of mathematics with other sciences (e.g. biology, genomics, chemistry, computer sciences …). These structures strive at developing new areas of research where mathematics is known to play a founding role as it did in the development of physics. (cross-disciplinary centres; mathematical sciences; interaction of mathematics).

Extreme Conditions Facilities

All facilities where materials are studied under extreme physical conditions as in High Magnetic Field Laboratories, High Pressure Laboratories, Low Temperature Laboratories, High Radiation Facilities, and Microgravity platforms.

Gravitational Wave Detectors and Observatories

Instruments using laser interferometry between freely hung test masses up to several km apart in vacuum. The lengths of two perpendicular arms, defined by the test masses, are compared and fluctuations in the arm length differences are recorded and analysed for potential GW signals. Links to earth observation.

High Energy Physics Facilities

High Energy Physics Facilities include accelerators, colliders, targets, light sources and detectors of high energy particles through electrostatic or oscillating fields accelerating particles to speeds sufficient to cause nuclear and particle reactions.

Mathematics Centres of Competence

Mathematics centres of competence develop mathematical models for applications in all sciences and engineering, including social sciences, and medicine. They analyse the models, develop and implement algorithms for the simulation of the models as well as for the optimization and control of the involved processes. They provide transversal competences which allow transferring concepts and methods from one specific science to another and they also provide consulting concerning the use of methods and their implementation for specific applications. When needed, they generate the basic mathematical theory that is needed to perform the described tasks. (mathematical modelling; numerical and statistical simulation; control theory; optimization; mathematical algorithm repository).

Micro and Nanotechnology Facilities

Micro and nanotechnology facilities deals with the understanding and control of matter at the nanoscale and microscales, at dimensions between approximately 1 and 1000 nanometers, involving imaging, measuring, modelling, and manipulating matter at this length scale.

Nuclear Research Facilities

Nuclear Physics facilities include accelerators, colliders, targets and detectors to study the atomic nucleus, the nuclear matter including its fusion and fission. The facilities can be classified according to their objects of study (hadrons, nuclei, applications), the probes that are used to investigate them (lepton/ photon or hadron/heavy ion beams), or simply by the size of the facility and the type of reactions involved in the various nuclear processes.

Safety Handling Facilities

Facilities that are required to handle materials that potentially cause biosafety, chemical, radioactive, explosive, or engineering hazards. Also clean rooms and Actinide Handling Facilities would be included. Includes BioSecurity Level-4 Laboratories.

Space Environment Test Facilities

Includes planetary/space environment simulation chambers and space environment exposure facilities as well as space plasma physics facilities

Telescopes

Includes ground-based telescopes with (1) optical and/or near infrared telescopes, interferometers or (2) reflector telescopes with mirrors of different diameters, operating at radio frequencies, or infrared and/or optical wavelengths and (3) Space-borne telescopes orbiting the earth including a wide range of wavelengths, from gamma-rays to the radio.

Underground Laboratories

Underground spaces providing experimental areas of reduced cosmic ray background, reduced seismic noise etc. for a range of experiments in physics and particle astrophysics. Open to members of collaborations involved in installing and running experiments. These facilities also have relevance to ICT and Material Sciences, Environment, Biological and Medical Sciences, Physics.

Social Sciences

Data Archives, Data Repositories and Collections

A digital data archive is a centre of expertise in data acquisition, preservation, management, dissemination and promotion of an access to the national and international collections and repositories of digital data. These type of RIs are particularly acute to the social sciences, which often rely on the aggregation of longitudinal data, and to the humanities, which often rely on preservation, but they can be relevant for other domains, particularly, the life and environmental sciences and the medical sciences.

Data mining and Analysis (Methodological) Centres, including statistical analysis

Centres of expertise or methodological resources for extracting patterns from large data sets by combining methods from statistics and artificial intelligence. These RIs enable researchers to overcome the challenge of working with increasingly larger data-sets. Data-mining and statistical techniques populate every scientific domain but what counts as data is domain specific. Therefore, this category should be understood as specific to social sciences because it refers to data in the social sciences.

National Statistical Facilities (offices)

Centres of expertise responsible for the collection and publication of statistics related to the economy, population and society at international, national and regional levels. These infrastructures have been traditionally created by the states but constitute as well powerful resources for the social scientists in particular.

Registers and Survey-led Studies/Databases

Organized and systematic collection of data (time or spatial series) for one or more purposes (research, evidence-based policy, non-governmental organisations) in digital form or not. These type of RIs are particularly acute to the social sciences, which often rely on the aggregation of masses of longitudinal data but they can be relevant for all the other domains, that is, the humanities, the life and environmental sciences, the physical sciences and engineering, and the medical sciences.

Research Data Service Facilities

Facilities for clustering research data and making it permanently accessible, as well as facilities for the provision of all sorts of data services. These often include meta-infrastructures. These types of RIs are particularly relevant to Humanities and Arts; Social Sciences, Medical sciences.

Appendix 2 – List of Research infrastructures in the Upper Rhine region (all domains)

ESFRI domain	Name	Topic	Highlight	Kind of RI	In ESFRI?	Location
Environment	IAGOS – In-service Aircraft for a Global Observing System	Climate Research	IAGOS aims to establish and operate a first-class research infrastructure for highly relevant observations of atmospheric composition on a global scale. IAGOS is based on autonomous monitoring devices that are installed in a fleet of up to 20 internationally operating passenger aircraft.	Distributed	ESFRI landmark (entry 2006)	Karlsruhe
Environment	ICOS – Integrated Carbon Observation System	Climate Research	ICOS is a European research infrastructure, which provides continuous, high-quality, standardised data on the concentration of greenhouse gases in the atmosphere. ICOS consists of three observation networks – atmosphere, ecosystem and ocean – spread over Europe, the Baltic Sea and the North Atlantic	Distributed	ESFRI landmark (entry 2006)	Karlsruhe
Environment	OZCAR	Critical Zona Observatory, research and Applications	Critical Zona Observatory, research and Applications	Distributed	No	Strasbourg
Environment	RESIF/EPOS	French Seismic and geodetic network / European Plate Observing System	A national equipment for the observation and understanding of the solid Earth.	Distributed	2008 EPOS	Strasbourg

Health and food	BioMedIT	Information and computational service infrastructure network to support biomedical research in Switzerland	BioMedIT will form an integral part of SIB's contribution to the SPHN (Swiss Personalized Health Network) initiative	Virtual	No	Basel
Health and food	CELPHEDIA-Phenomin	French national infrastructure in mouse phenogenomics	Development of in-vivo animal models	Distributed	2006 INFRAFRONTIER	Strasbourg
Health and food	ECRIN	European Clinical Research Infrastructures Network	Multinational standards for clinical trials	Distributed	2006 ECRIN	Freiburg
Health and food	FLI	France Life Imaging	In vivo imaging community	Distributed	2008 EUBIO	Strasbourg
Health and food	FRANCE GENOMIQUE	French national genomics and bioinformatics infrastructure	Infrastructure of genomics and bioinformatics.	Distributed	No	Strasbourg
Health and food	FRHA	France HADRON	Applied research in proton or light ions hadrontherapy	Distributed	No	Strasbourg
Health and food	FRISBI	French infrastructure for Integrated Structural Biology	Infrastructure for integrative structural biology approaches, from the molecular to the cellular level	Distributed	2006 INSTRUCT	Strasbourg
Health and food	INGESTEM	National Infrastructure for pluripotent stem cells and tissue engineering	National Infrastructure for pluripotent stem cells and tissue engineering	Distributed	No	Strasbourg

Health and food	NAKO	The National Cohort	Nationwide, long-term epidemiological study	Distributed	No	Freiburg
Health and food	Profi	Proteomics French infrastructure	Infrastructure in the field of Proteomics.	Distributed	No	Strasbourg
Health and food	SBP	Swiss Biobanking Platform	National coordination platform for human and non-human biobanks	Virtual	2006 BBMRI	Basel
Health and food	SCTO	Swiss Clinical Trial Organisation	Central cooperation platform for patient-oriented clinical research in Switzerland	Virtual	2006 ECRIN	Basel
Health and food	Swiss BioImaging	Swiss Microcopy and Imaging Core Facility Network	Main network of resources	Virtual	No	Basel
Health and food	SwissPedPha	Center for Pediatric Systems Pharmacology and Technology	New research infrastructure will benefit not only national but also international networks	Virtual	No	Basel
e-RI	CDS-ASD	Strasbourg Astronomical Data Centre	Development of the astronomical Virtual Observatory	Virtual	No	Strasbourg
e-RI	FIT	Infrastructure for Large-Scale Experimental Computer Science	Infrastructure for Large-Scale Experimental Computer Science	Virtual	No	Strasbourg
e-RI	France Grilles	France Grilles	DCI - Distributed Computing Infrastructure	Virtual	No	Strasbourg
Physical sciences and engineering	ESS – The European Spallation Source	Neutron research	ESS will represent a new technical milestone as the world's most powerful facility in neutron research.	Single-site (Lund, SE)	ESFRI landmark (entry 2006)	Karlsruhe

Physical sciences and engineering	METSA	Transmission Electron Microscopy and Atom Probe	National network providing the French scientific community unique instruments in the field of Transmission Electron Microscopy and Atomic probe.	Distributed	No	Strasbourg
Physical sciences and engineering	RENARD	Electron Paramagnetic Resonance	Interdisciplinary Electron Paramagnetic Resonance National Network	Distributed	No	Strasbourg
Physical sciences and engineering	W 7-X* – The Wendelstein 7-X Stellarator	Fusion research	Harnessing the power source of the sun – that is the goal of the scientists at the Max Planck Institute for Plasma Physics (IPP) in Garching and Greifswald. They are developing the theoretical and physical fundamental principles for a fusion power plant that derives energy from the fusion of hydrogen nuclei to helium.	Single-site (Greifswald, DE)	No	Karlsruhe
Social and cultural innovation	COLLEX-PERSEE	Collections d'excellence pour la Recherche - Persée	A distributed infrastructure that was created to bring together researchers seeking scientific documentary resources and to facilitate their usage	Distributed	No	Strasbourg (BNUS)
Social and cultural innovation	DARIAH – Digital Research Infrastructure for the Arts and Humanities	Arts and Humanities	The grand vision for DARIAH-DE is to facilitate the interoperability, long-term access to and use of tools and research data in the Digital Humanities.	Virtual	ESFRI landmark (entry 2006)	Karlsruhe
Social and cultural innovation	Humanum	Large facility for digital humanities	This infrastructure aims to facilitate the digital turn in humanities and social sciences.	Virtual	2006 DARIAH	Strasbourg

Social and cultural innovation	NUMEDIF	NUMérique pour l'Edition et la DIFfusion de la production scientifique	A national infrastructure serving the editorial activity of all public research and higher education organisations (CNRS, Universities).	Distributed	No	Strasbourg
Social and cultural innovation	PROGEDO	Data Production and Management	Data Production and Management	Distributed	2006 ESS, CESSDA & SHARE 2016 GGP	Strasbourg
Social and cultural innovation	SDHC	Swiss Digital Humanities Center	Guarantees the long-term accessibility of research data in the Humanities	Virtual	No	Basel

Appendix 3 – Items and criteria of interest for a research infrastructure database

Item	Details
Unit	Coherent set of infrastructures, facilities and/or software brought together to serve laboratory research in a well-defined field.
Technological resources	Know-how, scientific and technical expertise supplied, Service, catalogue, access, maximum theoretical and used capacity, developing and monitoring activities, selection of projects, types of uses and users.
Property resources	Buildings/premises, surface area, equipment, facilities.
Financial resources	Investments, operation, maintenance, management, grant, mechanisms, complete cost calculation, working account, pricing.
Human Resources	Staff, number, quality, assignment, FTE, skills management.
Organisational Resources	Governance, functional organisation chart (assignment, dedicated staff), **quality** (quality approach, ISO standard, well-define operation, activity reports), IS, Databases…
Openness	Internal projects and with academic or private outside partners, investment (local, national, European or international), project type: R&D, service, co-development, procedures: availability, service, collaboration…
Networks	National and international.
Visibility	Communication media, participation in scientific events, organisation of workshops of meetings, web site, referencing, site visit, development plan.
Training and Education	Continuous education or training young researchers.
Production	Publications or patents, internal and external (users).
Outlooks and Strategy	For medium and long-term development.
Users Committee / Scientific Board	-