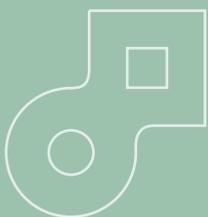
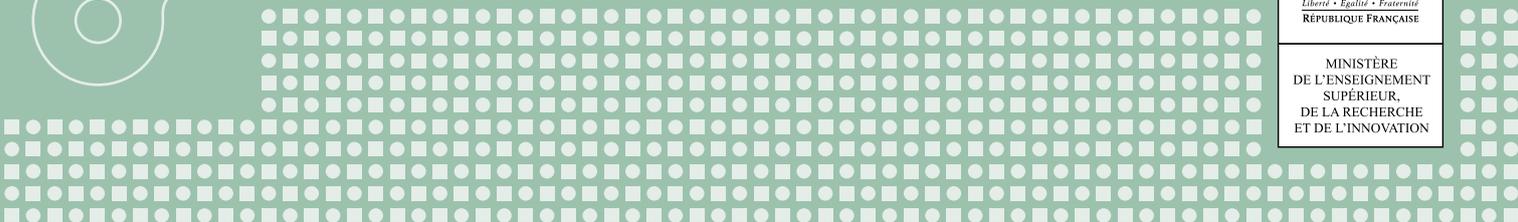


FRENCH NATIONAL STRATEGY ON RESEARCH INFRASTRUCTURES 2018 EDITION



www.enseignementsup-recherche.gouv.fr



FOREWORD



Frédérique VIDAL
Minister of Higher Education,
Research and Innovation

Pushing the frontiers of knowledge often requires the use of major research equipment, technological prowess nurtured and serving scientific prowess.

These great research facilities are not working tools like the others. Their longevity, their ambitions, their costs are all peculiarities which it is important to appreciate the value while conducting a strategic reflection like the one which lead to the publication of the present roadmap.

Our country can only congratulate itself for supporting, over more than twenty years now, the development of networks of national and European infrastructures which have transformed the practices of the scientific communities. Today, major French facilities are involved in almost all infrastructure support projects in the European Research Framework Program.

Halfway through the H2020 program, more than € 160 million of European grants have already been raised in support of research infrastructures in addition to the Ministry's annual budget allocation. Naturally it is necessary to continue in this search for European co-financing, and I am striving with the ministry teams, that the resources devoted to research infrastructures are very significant in FP9.

But with ESFRI coming on board, research infrastructures' issues far outweigh the issues and the financial and policy capacity of the Framework Program. The strategic, scientific and financial challenges related to research infrastructures are such that sooner or later we will need to jointly program European and national investments in major research facilities.

This imperative of harmonization is already impacting the practices and cultures of data

management and data sharing that vary across domains, communities, countries, and organizations. As they become more demanding in terms of data, their conservation and reuse should be optimized to boost technological and societal developments.

The creation of data management infrastructures allows the sharing of European research results among its disciplines. Data infrastructures together form the basis of an open European digital space, a key element of future projects aimed at creating prosperity, jobs and well-being, as long as these data are considered as communicable and do not enter in an exceptional legal framework.

At a time when many researchers, funders and research organizations recognize the benefits of better data management, I welcome the efforts made by France to ensure the sustainability of research data issued from its research infrastructures. The responsibility of the State is engaged not only in terms of alignment of policies of data opening but also in terms of human resources to put in place to achieve this. This is particularly the meaning of the government's recent decision to mobilize high-performance computing to support its action in Artificial Intelligence.

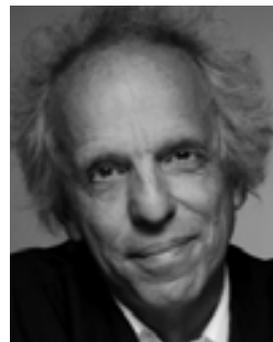
Research infrastructures have become incredible engines of knowledge, attractors of talents, catalysts of collaborations, image and scientific prestige carriers. By their status as facilitators of innovation, developers of new practices, demanding buyers of high technologies, they remain an ideal vector both for the transfer of knowledge towards public policies and for the transfer of technology to markets of scientific equipment of several billion euros.

The attractiveness of the research infrastructures relies mainly on the excellence of

the highly qualified personnel, researchers, engineers, technicians and administrators who operate them. I would particularly like to thank the operational teams of the 99 infrastructures of this new edition of the national roadmap for their efforts to give full transparency to the calculation of the full cost of the infrastructures' exploitation, which provides the basis for an objective valorization of the knowledge they produce.

Based on this French know-how recognized by all, the national research infrastructures, including their numerical declinations, must appear without any complex on the list of European orientations and in particular of the next 9th European Framework Program for research and innovation, with the certainty that only equipment of excellence will attract the ambitious and innovative projects of the best French, European and international scientists.

INTRODUCTION



Alain BERETZ
Director General of Research
and Innovation,
Ministry of Higher Education,
Research and Innovation

More than ever, scientific issues impose the challenge of building research tools at the forefront of scientific and technological knowledge. The frontiers of knowledge are pushed to such an extreme point that only major technological achievements are able to verify their experimental viability.

The observation, the measurement, the experimentation, the supercomputing, the storage and sharing of data, all suppose to use big instruments with technical performances beyond the existing ones and integrating interdisciplinarity as a source of innovation. These tools constitute a mandatory condition for future discoveries as well as the product of the past scientific and technological advances. Large equipment were created and monitored by national, European or international organizations, which require outstanding instrumentations but also substantial financial and human resources, with the support of the public authorities.

In parallel to these major programs, a number of instruments shared amongst many actors on various sites have been developed in recent years: new modes of microscopy and imaging, new high throughput screening devices, virtual experiments, social, environmental and health databases, corpus of digitized texts with their operating tools. In France, the support of the Future Investment Program largely contributed to this success.

In this context, the development of a national strategy for infrastructures is required. It should take into account the more recent inputs of technology, the up-to-date developments of scientific practices, the rich articulation with European or international networks, the human and financial investments, the benefits for innovation as well as the recent reconfigurations of the French research landscape.

The update 2018-2020 of the National Strategy for Research Infrastructures demonstrates the desire of the State, via its major research and higher education institutions, to meet the demands of knowledge and innovation. In line with the national roadmap on research infrastructures published in 2016, this update makes it possible to continue the national structuring effort concerning research infrastructures, particularly in the areas of health-biology and environment.

In addition, it focuses on the calculation of the full costs and the origin of the resources of the research infrastructures; exercise carried out for the first time and which must allow the improvement of the management of the infrastructures by their coordinators, the operators and the ministry.

It is also an opportunity to conduct a survey of current and estimated scientific data production in five years, as well as their management. The availability of research data, of which research infrastructures are very important providers, is a requirement that is now extended to the entire scientific community. However, it raises a huge challenge of sizing our e-infrastructures impacted by the considerable need for storage, data flow and computing resources that must be anticipated.

This document presents an update of the national landscape of research infrastructures, which are becoming every year more and more essential tools for research of excellence.

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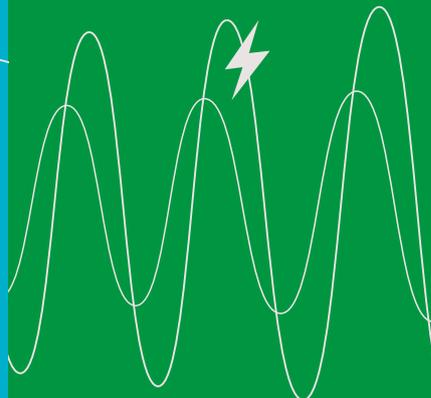
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THE VARIOUS TYPES OF LARGE RESEARCH INFRASTRUCTURES

▶ A RICH AND VARIED LANDSCAPE

The nation roadmap 2018-2020 retained 99 infrastructures, of which the form and content are highly varied. They are not limited to just the large instruments installed on a single site, but also take distributed forms. They are also, to varying degrees, influenced by the new capacities stemming from the information and communication technologies. They finally reflect organisational methods that are highly dependent on thematic communities and the techniques that they share. Several forms can be identified:

- on a single site: localised infrastructures, most often due to large-size instrumentation that requires a specific real estate programme
- distributed: networks of instrumented sites or platforms, observatories, collections, archives and scientific libraries
- dematerialised: virtual research infrastructures, databases, digital or e-infrastructures necessary for the whole scientific community
- infrastructures with a human network base (cohorts, experts, etc.).

▶ WHAT IS A LARGE RESEARCH INFRASTRUCTURE?

The principles that define a large research infrastructure can be stated as follows:

- it must be a tool or a device that has unique characteristics identified by the scientific community that makes use of it as required for conducting high-level research activities. The targeted scientific communities can be national, European, or international, according to the case.
- it must have governance that is identified, unified and effective, and strategic and scientific bodies for steering.
- it must be open to any research community that wants to use it, accessible based on peer-reviewed scientific excellence; it must therefore have suitable evaluation bodies.
- it can conduct its own research, and/or provide services to one (or several) communities of users that integrate the stakeholders of the economic sector. These communities can be present on the site, conduct work there on a one-off basis, or interact remotely.
- it must produce a multi-annual budget schedule and submit a formalised budget to the governing bodies.
- it must produce data management plan corresponding to the data opening rules and respecting the international embargo practices of the field involved.

► FOUR CATEGORIES OF RESEARCH INFRASTRUCTURES

This French roadmap is built around four categories of research infrastructures, according to their national or multinational nature, their method of governance and their budget support. The criteria presented hereinabove apply to the four categories, which are defined on the following principles:

- the **International Organisations** (IOs) are legally based on an intergovernmental convention which is sometimes doubled with an inter-agency agreement and statutes that describe in a detailed way the implementation of the convention or agreements. The intergovernmental convention, which is associated with a financial protocol, in particular specifies the objectives of the organisation, the conditions for membership, the operating bodies, and the particulars on contributions for member States;
- the **Very Large Research Infrastructures** (VLRIs) pertain to a government strategy resulting in several actions of the financial law and budget earmarking of the MESRI. 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. VLRIs are under the scientific responsibility of the research operators;
- the **Research Infrastructures** (RIs), depend on the choices of the various research operators and are implemented by them, whether by research Alliances or their members, or public establishments due to their particular missions;
- the **projects**, whether in the process of construction or already producing but which have not yet reached full maturity according to the criteria listed hereinabove, already exist and have importance in the French research landscape which warrants listing on the roadmap. This status for an infrastructure is of a transient nature and will be analysed again at the next update of the roadmap.

These 4 types do not show a hierarchy of excellence or technological nature. Apart from the IOs, the legal or judicial structures, the budget dimension or thematic groupings can take on various forms and therefore are not restrictive criteria distinguishing the VLRIs from RIs or projects.

It can be noted that according to the criteria presented hereinabove, the test infrastructures and demonstrators used in the framework of large equipment programmes (energy, transport, building, agro-foods, space, nuclear, defence, etc.) that can conduct research but without an outside opening, are not intended to be included into this roadmap.

The 2018 update of the national roadmap provided an opportunity to calculate the full costs of the research infrastructures and to specify the origin of their

FULL COSTS, RESOURCES AND PERSONNEL OF RESEARCH INFRASTRUCTURES

annual resources. Highlighting the real value of the research infrastructures, it is the opportunity to characterize the research effort corresponding to these major research tools, to identify their principal evolutions and thus to provide support in international negotiations.

The year 2016 was chosen as the base year for this large-scale exercise, which was made possible thanks to the strong involvement of all stakeholders. The total cost of the research infrastructures, excluding infrastructure under construction, is estimated at € 1 338 million for 2016. This amount takes into account, beyond the budgetary resources identified, all in-kind contributions that participate in a less visible way in support of the needs of the infrastructures.

The full cost of each research infrastructure and the number of full-time equivalents worked are indicated in this document, with the exception of the infrastructures that have been included into the roadmap in 2018 and thus were not concerned by this first exercise.

A booklet presenting the main results and conclusions of this survey is also available.

RESEARCH INFRASTRUCTURES AND DATA

The vast majority of research infrastructures produce, handle, process and/or exchange data. The 15 research infrastructures that consume the most storage resources declared a total of 540 Petaoctets (Po). Within the next 5 years, the figure should be multiplied by 5.

The massive growth in demand for computing resources in recent years calls for a coherent and ambitious strategy at the levels of infrastructure capacity (networks, computing and processing, storage and archiving capacities), associated services, and more generally a rethinking of the place of research data.

Naturally, our national strategy has been conceived in synergy with developments in Europe. In terms of e-infrastructures, several ambitious projects will mark the landscape for years to come. The European Commission has launched the European Cloud Initiative, which has two complementary components: the European Data Infrastructure and the European Open Science Cloud.

The key objectives being that all VLRI and RI which produce, manipulate, process and/or exchange data can be securely interconnected, while ensuring European data sovereignty.

- To achieve this, while addressing the challenge of restructuring and upgrading infrastructures at the national and regional level, is particularly important in view of the evolution of data volumes expected over the next 5 years.
- At the IR level, the data must comply with the FAIR (Findable, Accessible Interoperable and Reusable) principles, which will be widely disseminated and put into practice along with a framework for data cross-fertilization between communities, to encourage the reuse of research data. The first step is to make the implementation of a Data Management Plan mandatory as is already the case for H2020 projects.

As an extension of the digital republic law, which encourages public institutions to make their data open and reusable, France is actively involved in 3 international movements:

- *it participates in the definition and construction of the EOSC;*
- *it joined the Go GAIR initiative as a founding member in 2017;*
- *it is committed to building an open science ecosystem as part of the partnership for open government.*

RESEARCH INFRASTRUCTURES AND THE ROADMAP

► LISTING ON THE ROADMAP

The national roadmap for research infrastructures determines the main framework for public intervention in the strategic management of these infrastructures. This exercise, carried out on a regular basis by the Ministry of Research in consultation with the Research Alliances, and the research institutions or organizations, affirms the will of the State to structure the infrastructure landscape at national scale. The inclusion of a research infrastructure on the national roadmap represents a label of quality and recognition of its value in the National Research Strategy (SNR). The support of these infrastructures is intended to ensure the maintenance of French positions in major European research projects, but also to continue the strengthening of national facilities that remain the first point of access for our researchers. This ambition presupposes an increased requirement in the governance of research infrastructures, which must apply at all levels: a selective and hierarchical choice of projects to support, a good evaluation of the construction costs but also the control of the exploitation costs. Such approach is the only way of guaranteeing the long-term sustainability of the research infrastructures, alongside with the necessary consideration of their economic, societal and cultural impact.

► NATIONAL AND EUROPEAN ROADMAPS

The work of updating the national road map for research infrastructures was closely linked to the work done in parallel for the revision of the roadmap for European research infrastructures ESFRI. The majority of EU Member States are engaged in the same strategic exercise: ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri-national-roadmaps.

Designing and developing pan-European and international infrastructures implies concerted action at European level, in particular to optimize the choice of host countries. Research infrastructures play a leading role in the construction of the European Research Area and are an integral part of the Excellence Pillar of the European Framework Program. The clear definition of national choices will enable our country to weigh effectively on future orientations at European and international level. The numerous participations of France in European infrastructures are mentioned in this document.

UPDATE PROCESS OF THE NATIONAL STRATEGY FOR RESEARCH INFRASTRUCTURES

Previous editions of the National Research Infrastructures Strategy were published in 2008, 2012 and 2016. This 2018 update is the result of a collective process, with several highlights, where research Alliances and research institutions were the main actors with the constant support of the General Direction of Research and Innovation of the ministry in charge of research (DGRI).

A launching day for this update took place on 10 November 2016 and defined the framework of this action: the link with the European update (ESFRI roadmap), the setting up of thematic coordination groups Alliances/Organizations/Ministry and a piloting group of DGRI.

In each area, the candidate infrastructures were identified by the coordination group. In spring 2017 a detailed questionnaire was sent to them to be filled in. Description sheets were extracted from each of the questionnaire and validated by the research institution in charge of the infrastructures. Finally, thematic summaries, corresponding to those in this document, have been prepared by DGRI.

The research infrastructures candidates for inscription on the 2018 national roadmap were presented to the High Council of Very Large Research Infrastructures (HC-TGIR) in December 2017. This independent body, which brings together 15 experts from all scientific fields, with an extensive experience in management of major infrastructures and major research projects, analyzed the RI landscape thus presented. Its report was finalized in February 2018.

On the basis of this analysis, the Steering Committee of Very Large Research Infrastructures (CD-TGIR) has decided on the list of infrastructures officially registered by France. This body, chaired by the Director General of the DGRI and composed of the presidents of the research Alliances, the CNRS and the CEA has thus endorsed the French landscape.

Finally, the presentation of this landscape is the subject of this document, as well as of the institutional ministerial website updated regularly.

The publication of these documents led to the organization on May 17, 2018 of a national day of presentation of the national roadmap for research infrastructures at the ministry in charge of research.



**SOCIAL SCIENCES
AND HUMANITIES**



Social Sciences and Humanities

The development of ICT combined with that of the internet has provided access to massive amounts of data and means of computing that allow it to be processed, as well as to new ways to analyse non-digital resources. The disciplines in social sciences and humanities (SSH) are as such confronted with a momentum that is transforming the very profession of the researcher. As such the SSH research infrastructures have to enable the creation and manipulation of large and very heterogeneous corpora, of a qualitative or quantitative nature, capable to open up new ways of doing research and to encourage interdisciplinarity. Part of a social space largely open to the world, infrastructures contribute to the valorisation of a scientific and cultural heritage and are of interest to all institutions grouped together in the Athena Alliance.

OBJECTIVES

- Offer support services to researchers, who work with digital texts, fixed and animated images and other digital materials.
- Facilitate the use of digital tools for the work on non-digital sources.
- Design new ways of digital scientific publication equipped with tools for online treatment, acquirement and collaboration
 - Produce, access, take advantage of document and compare quantitative data coming from public statistics, major scientific surveys and data from opinion polls
- Ensure territorial deployment of the Very Large Research Infrastructures (VLRI)
 - Develop new (inter-)disciplinary and technological skills

1 DIGITAL HUMANITIES

Facilities for storing, and the interactivity that is inherent to the digital combined with the wide dissemination of access to the World Wide Web network have opened up renewed opportunities in terms of appropriation and handling of research resources. Consequently, we have seen a diversification in the locations of digital resource production which have resulted in the creation of many platforms dedicated to the digital humanities. They form clusters for bringing together disciplinary and technological skills that offer many services to support researchers in the humanities who use ICT either directly because the research data is digital or as an environment allowing for access to new processing tools. These platforms, which are often located in the Social Sciences and Humanities Centres (MSH), are developed in very close coordination with the **HUMA-NUM VLRI**.

The VLRI provides them with tools and services for storing, processing, interoperability, diffusion, exposure, reporting and archiving of digital data dedicated to SSH by including the sedimentation aspects of knowledge and the specific needs in terms of access to the latter. On a European level, HUMA-NUM coordinates the participation of France in the European infrastructures DARIAH ERIC and CLARIN ERIC.

2 DIGITAL EDITION FOR THE SSH

The **OpenEdition** infrastructure designs new ways of digital scientific publication equipped with tools for online treatment, acquirement and collaboration. The infrastructure allows for improving the impact of interdisciplinary research projects and their ability to transfer their results to the social and economic stakeholders in order to meet the social challenges at the national and European levels. OpenEdition is a leading stakeholder on European and international levels with regard to innovation in the field of open-access scientific publishing. This infrastructure contributes to improving the quality of the research through better circulation of the scientific know-how and through the improvement of the conditions for evaluating it.

This entails a guarantee for transparency, scientific and editorial quality as well as sustainability.

OpenEdition is also listed in the “Scientific and technical information” field in order to highlight its dual nature as a research infrastructure for the SSH and for digital publishing.

3 DATA INFRASTRUCTURES

Public statistics, major scientific surveys, management data and data from opinion polls represent an essential source of knowledge for the social sciences. The construction of European indicators on society via longitudinal surveys is a challenge that contributes to constructing Europe. The **PROGEDO** VLRI is designed to organise the survey data production and management services for SSH research in France and to develop a data culture within the universities. The challenge for this VLRI is to provide France with the possibility of taking an active role in building these European society indicators. The challenge is also to allow researchers to anchor their research on the data produced by these major surveys.

The infrastructure is based on the Data Platform Universities (DPUs) established within the Social Sciences and Humanities Centres (MSH) and is the head of the data dissemination network Quetelet PROGEDO Diffusion. The VLRI is built around four departments corresponding to the European consortia CESSDA ERIC (Council of European Social Sciences Data Archives), ESS ERIC (European Social Survey), SHARE ERIC (Survey of Health, Ageing and Retirement in Europe) and GGP (Generation and Gender Program).

4 AN INFRASTRUCTURE FOR A TERRITORIAL INTERFACE

The Social Sciences and Humanities Centers Network (**RNMSH**) and its 23 centers are instruments for transforming SSH research through interdisciplinarity and the development of project-based logic. The network plays an important role in developing and disseminating interdisciplinarity and structuring the associated know-how. MSH are places for strong partnerships between universities, organisations (the CNRS, in particular) and local authorities.

In terms of infrastructures, two major mission of the MSH are essential:

- relaying in order to deploy and locally anchor the national structures which are in particular the two VLRI in SSH and the Thematic Valorisation Consortium (CVT) for the SSH. Due to the link of these national structures with European

structures, the MSHs facilitate the access for scientific communities to the sphere of European research infrastructures (European forum ESFRI, and the “infrastructures” section of the Horizon 2020 programme);

- accelerating the required transformations of the SSH for research on projects following the Social Challenges approach. As such, the MSH encourage strongly innovative research and risk taking, whether internal to the SSH scope or conducted with other disciplines.

5 A TRANSVERSE INFRASTRUCTURE FOR HERITAGE SCIENCES

In recent years, heritage sciences have experienced a considerable boom in Europe. The European infrastructure **E-RIHS** responds to the need to establish a robust structure for organising the field of research and strengthen the international position of Europe in this inherently interdisciplinary field. Furthermore, we expect from E-RIHS a consolidation in the articulation, already well established in this field of research, between methods stemming from physics, chemistry, biological anthropology, geology and information sciences on the one hand, and the traditional methodology of interpretive disciplines (history, art history, archaeology, etc.) on the other. This transversal nature of E-RIHS is brought to the forefront by also integrating the infrastructure into the “Material Sciences and Engineering” field.

CATEGORY	NAME	FULL NAME	ESFRI
VLRI	<i>Huma-Num</i> ¹	<i>Very large research infrastructure for digital humanities</i>	<i>DARIAH (2006) CLARIN (2006)</i>
VLRI	Progedo	PROGEDO Data infrastructure	ESS (2006) CESSDA (2006) SHARE (2006)
RI	<i>ERIHS-FR</i> ²	<i>European Research Infrastructure for Heritage Science</i>	<i>ERIHS (2016)</i>
RI	<i>MÉTOPES</i> ³	<i>Methods and tools for structured publications and editions</i>	
RI	<i>OpenEdition</i> ⁴	<i>Open access to scholarly communication in the humanities and social sciences</i>	
RI	<i>RnMSH</i> ⁵	<i>French Network of Social Sciences and Humanities Centers</i>	

1 RI at the interface with the sector "Scientific and Technical Information".

2 RI at the interface with the sector "Material Sciences and Engineering".

3 RI at the interface with the sector "Scientific and Technical Information". RI description can be found in the sector "Scientific and Technical Information".

4 RI at the interface with the sector "Scientific and Technical Information". RI description can be found in the sector "Scientific and Technical Information".

5 RI at the interface with the sector "Scientific and Technical Information".

HUMA-NUM



Very large research infrastructure for digital humanities

Huma-Num is a very large research infrastructure which aims to facilitate the digital turn in Humanities and Social Sciences.

To perform its missions, Huma-Num's organization is based on two pillars:

- consortia, funded by Huma-Num, which are composed of research projects and teams sharing common scientific interests;
- a unique technological device, provided on a national scale and based on a vast network of partners.

This infrastructure offers a variety of platforms and tools to store (Huma-Num-Box), process (shared toolbox), share (NAKALA) and link (ISIDORE) research data. Huma-Num is entrusted with France's participation in two European Research Infrastructure Consortia (ERIC): DARIAH (Digital Research Infrastructure for the Arts and Humanities) and CLARIN (Common Language Resources and Technologies Infrastructure). It is also involved in other European projects (H2020) and different international initiatives.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Huma-num works in liaison with the knowledge industry, search engine developers and big data services in order to improve the adoption, by SSH research communities, of the digital data economy issues.

DATA

Estimated volume stored in 2017: 1 Po

Estimated volume stored in 5 years: 4 Po

Data access: full

Full cost

—
2.9 M€ in 2016

Personnel

—
12.2 FTE in 2016

International dimension

DARIAH, ESFRI Landmark

Directors: Jennifer Edmond, Frank Fischer, Toma Tasovac

Coordinating country: France

Partner countries: DE, AT, BE, CY, HR, DK, GR, IE, IT, LU, MT, NL, PL, PT, SI, RS, SE

Website: www.dariah.eu

CLARIN, ESFRI Landmark

Director: Franciska de Jong

Coordinating country: Netherlands

Partner countries: AT, BG, CZ, DK, EE, FI, DE, GR, IT, LT, NO, PL, PT, SI, SE, UK, FR (observer)

Website: www.clarin.eu



Category: VLRI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Villeurbanne

French supporting institution: CNRS

Director: Olivier Baude

Construction: Operation:

2013

2013

Stakeholders in France: AMU, Campus Condorcet

Contact in France:

direction@huma-num.fr

www.huma-num.fr



Category: VLRI

Type of infrastructure: Virtual

Infrastructure location: Paris

French supporting institution: CNRS, EHES

President: Pascal Buléon

Director: Sebastien Oliveau

Construction: Operation:

2008

2008

Contact in France:

pascal.buleon@unicaen.fr

www.progedo.fr

PROGEDO is the main actor of governmental policies for the production and the management of data in social sciences and humanities. The mission of the infrastructure is to increase the level of national structuration amongst research communities. This is achieved by a development strategy, associating research organisations, large organisations and universities while also strengthening France's position in the landscape of European research.

PROGEDO contributes to the collection, documentation, preservation and promotion of the use of vast sets of data, indispensable to research in social sciences and humanities and helps the establishment of facilities of secure access to micro-data. PROGEDO also supports the implementation of large international surveys and offers access to certain foreign data bases in the social sciences and humanities.

On a regional level the PROGEDO data platforms are established within the universities. They represent a strong asset for education and research on a local scale, as well as an entry point to European and international infrastructures.

PROGEDO also collaborates with the ATHENA and AVIESAN alliances to orchestrate multidisciplinary work between large fields jointly concerned by social sciences and humanities.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Institutions such as CNAV contribute financially to some european surveys (as for instance SHARE); socio economic impact: better knowledge and contribution to decision-making, especially for public policies (values and opinions surveys, such as the Violence and Gender Relations survey (VIRAGE) coordinated by INED for the prevention of delinquency) and in health sector.

DATA

Estimated volume stored in 2017: 0.1406250000 To

Estimated volume stored in 5 years: 0.7031250000 To

Data access: full

Full cost

6.9 M€ in 2016

Personnel

38.5 FTE in 2016

International dimension

CESSDA, ESFRI Landmark

ESS, ESFRI Landmark

SHARE, ESFRI Landmark

Coordinating countries: CESSDA - NO, ESS - UK, SHARE - DE

Websites: www.cessda.net, www.europeansocialsurvey.org, www.share-project.org

E-RIHS

European Research Infrastructure for Heritage Science France

E-RIHS supports advanced investigations in heritage science, addressing cross-disciplinary research questions related to the history, interpretation, diagnosis and preservation of cultural and natural heritage, through a synergy of collaboration between national facilities. Heritage materials (from paintings, ceramics, glasses, metals, paleontological specimens, lithic materials, graphic documents, etc.) are often extremely heterogeneous, chemically complex and multi-scale, and their study requires an integration of the full power of novel analytical and imaging techniques within its instruments, competencies, and training. Through a concerted procedure, E-RIHS delivers an integrated access to cutting-edge analytical technologies and scientific archives, through five platforms:

- FIXLAB for large-scale analytical facilities (synchrotron, ion beam, laser facilities, etc.);
- MOLAB, a set of advanced mobile instruments that travel to a site to study materials in situ;
- DIGILAB for online scientific tools and data, making them findable, accessible, interoperable and re-usable (FAIR principles), – ARCHLAB for physical archives;
- EXPERTLAB for the setting-up of expert panels that initiate integrated projects for the study of heritage assets.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

E-RIHS France fosters cooperation between its members. This will lead to innovation in Heritage Science both in terms of methods and of technologies. These innovations will help operators and industries from the heritage sector, especially those in charge of museums, sites and monuments, as public-facing institutions. They lead to the development of instruments, methods and databases that can benefit to other scientific and industrial sectors with comparable specificities.

DATA

Estimated volume stored in 2017: 2,000 To

Estimated volume stored in 5 years: 6,000 To

Embargo period: 30 months

Data access: full

Full cost

4.1 M€ in 2016

Personnel

38.7 FTE in 2016

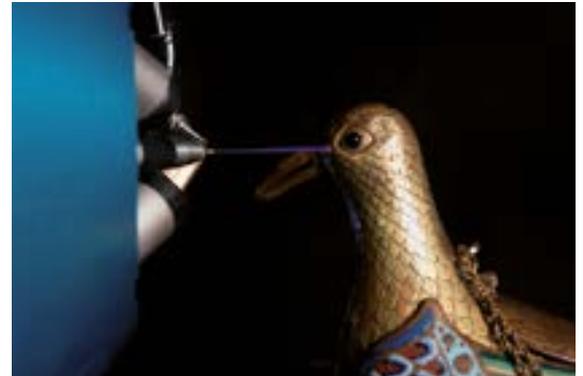
International dimension

E-RIHS, ESFRI Project

Coordinator: Luca Pezzati

Partner countries: DE, BE, CY, ES, GR, HU, IE, IS, NL, PL, PT, CZ, UK, SI

Website: www.e-rihs.eu



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Gif-sur-Yvette, Paris

Other sites: Champs-sur-Marne, Cergy-Pontoise, Marseille, Palaiseau, Toulouse, Versailles, Saclay, Saint-Aubin, Orsay

French supporting institution:

CNRS, INRIA, MNHN, Fondation des Sciences du Patrimoine

Directors: Loïc Bertrand, Isabelle Pallot-Frossard

Construction: Operation:

2019

2022

Contact in France:

loic.bertrand@synchrotron-soleil.fr

isabelle.pallot-frossard@culture.gouv.fr

www.erihs.fr

French Network of Social Sciences and Humanities Centers



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Lyon, Saint-Étienne, Nanterre, Caen, Cachan, Polynésie Française, Tours, Orléans, Nantes, Clermont-Ferrand, Dijon, Nancy, Metz, Pessac, Rennes, Toulouse, Nice, Poitiers, Besançon, La Plaine Saint-Denis, Montpellier, Saint Martin-d'Hères, Lille, Strasbourg, Aix-en-Provence

French supporting institution: CNRS, Fondation Maison des Sciences de l'Homme

Director: Bertrand Jouve

Construction: Operation:

2006

2006

Stakeholders in France: AMU, UCA, UFC, UGA, UPF, Languedoc-Roussillon Universités, Université fédérale de Toulouse Midi-Pyrénées, Université François-Rabelais, Universités de Nantes, d'Angers, de Bourgogne, de Caen Normandie, de Lorraine, de Poitiers, de Strasbourg, de Lille, Universités Lyon 2, Nice - Sophia-Antipolis, Paris 1, Paris 13, Paris 8, Paris Nanterre, Paris-Saclay, Rennes 2

Contact in France:
bjouve@msh-reseau.fr

www.msh-reseau.fr

The RNMSH network coordinates the twenty-three Social Sciences and Humanities (SSH) Centers. These centers aim at transforming SSH through the promotion of interdisciplinarity and project-based research. Twenty of them are service and research units jointly administered by the French National Centre for Scientific Research (CNRS) and some French universities. The centers play an active part in: - Deploying and implementing national programs throughout the French territory (especially in the fields of digital technology, scientific and technological information or valorization); - Coordinating and sharing research support services; - Supporting SSH-focused interdisciplinary projects conducted by junior researchers; - Structuring the implementation of local priorities by coordinating the research units of a site through highly federative projects and shared platforms; - Developing projects with a strong European and international dimension.

The strategic objectives of the RNMSH network are aimed at: - Giving the French SSH centers an international scope thanks to targeted cooperation agreements with foreign entities whose missions are in line with the MSH core activities; - Consolidating the scientific projects and education portfolios supported by the five RNMSH platforms (Spatio, Scripto, Audio-Visio, Cogito, Data); - Developing operational chains in order to facilitate the local anchorage of top-ranking scientific and technical information hubs; - Fostering innovative valorization initiatives at a local level and encouraging their spin-off.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The regional integration of each node of the network is part of the charter. Each SSH Center has research collaborations with public or private partners on his territory or beyond. Platforms of expertise and technological platforms of the Centres provide external services. The RI has also a privileged partnership with Athena Alliance's "Consortium de Valorisation". A working group about valorization indicators in SSH has been created in 2017 by the RI.

DATA

Estimated volume stored in 2017: 750 To

Estimated volume stored in 5 years: 1,500 To

Data access: restricted

Restrictions: Open access Data is a policy of the RI. As far as possible, data are openly accessible to researchers, excluding commercial use.

Full cost

43.7 M€ in 2016

Personnel

450.2 FTE in 2016

International dimension

RNMSH

Coordinator: Bertrand Jouve

Coordinating country: France

Partner countries: BE, TN

Website: www.msh-reseau.fr



EARTH SYSTEM AND ENVIRONMENTAL SCIENCES



Earth system and environmental sciences

The research infrastructures of the System Earth and Environment domain are essential to the progress of the knowledge on the processes at work within the main compartments of the planet, and between them.

The research data delivered by the infrastructures of the domain allow to:

1. understand, model, script and predict climate, biodiversity and resources changes;
2. monitor pollution and their impacts;
3. develop research on adaptation to global change or mitigation;
4. assist risk decision-making and assess the effects of public policies. They are oriented towards the production of services and economic development in the new sectors offered by energy and ecological transitions.

These infrastructures, often distributed, are very diverse. Some so-called "logistics" allow access to the ground such as fleets or stations. Others are networks of observation, experiment, collection and analysis devices. Others are virtual to allow the access and the provision of scientifically validated data as well as value-added products (models, maps, simulations ...).

They are designed on a European scale (ESFRI roadmap, *ENVIplus Environmental Research Infrastructures Cluster providing shared solutions for science and society*) or internationally. They are certified by research institutions and made consistent by the AllEnvi alliance. Supported by the MESRI, the institutions or the "Plan Investissement d'Avenir", they are multi-tutorships, their governance being adapted to the diversity of the institution partners. AllEnvi ensures the coherence of the whole system answering the needs of scientists, expressed during recurrent prospective exercises.

The field also includes international organizations (OI), carriers of downstream services in the environment and space sectors, such as ESA or Eumetsat, or companies like Mercator in connection with the Copernicus program. Only the European Center for Weather Forecasts Medium Term (ECMWF) is included in this roadmap since it provides to scientists data, tools and training. In addition, environmental sciences are also users of large analytical ("Soleil", ESRF...) and digital (Genci, Renater...) equipments.

"LOGISTICS" INFRASTRUCTURES

"Logistics" infrastructures are essential for the entire national community, and often international. They allow the acquisition of in situ data and the collection of samples. These are the fleets (**FOF** for boats, **SAFIRE** for aircraft), the contribution to the European consortium of **drilling** vessels (**IODP/ECORD**) or stations like **CONCORDIA** in the Antarctic. In addition to the roadmap, national systems exist, such as the "Balloon" fleet operated by CNES and the lacustrine and continental core drilling facility operated by the CNRS (C2FN: National Core Drilling Center) or the Arctic station of Svalbard co-managed with Germany by the French Polar Institute IPEV.

INNER EARTH

RESIF/EPOS is an observation infrastructure that gathers all the national geophysical resources dedicated to monitoring the hazards and resources of the inner Earth. Very integrative, it represents a structuring model of observation systems operated by several institutions. Its ambition is to open up to other types of data (geochemistry...). The Internal Earth Pole (FORM@TER) of the **Data and Services Center for the Earth System** completes the package and with a part of RESIF is the mirror of the ESFRI EPOS. The set consisting of geochemistry platforms and data derived from them, is going to be structured; this should strengthen the national and European positioning of geosciences in several areas of research and application.

ATMOSPHERE

The observation infrastructures on the atmosphere are mirrors of ESFRI. They are supported by historically structured communities studying greenhouse gases, via **ICOS**, the composition of the atmosphere via **IAGOS** and, more recently, the aerosols and reactive gases involved in air pollution via **ACTRIS**. The Atmosphere cluster (AERIS) of

the **Data and services center for the Earth system** gathers all the pre-existing centers and databases of the components of ACTRIS-FR and IAGOS.

OCEAN AND COASTAL

ILICO, dedicated to the littoral and coastal environments, gathers the observation systems of several institutions; it was built based on the European project Jerico. In the long term, the ocean domain will be fully covered by the observation infrastructures **EMSO**, **EURO-ARGO** and **I-LICO** with the potential addition of a high seas dedicated infrastructure built around the SOERE "Coriolis-temps-différé-Observations-Océaniques". The **OCEAN pole (ODATIS)** of the **data Pole and services for the Earth system** will integrate I-LICO data.

CONTINENTAL SURFACES

E-LTER-FR OZCAR is an observation infrastructure designed to study the Critical Zone (zone of interactions between lithosphere, hydrosphere, cryosphere, biosphere and atmosphere) in order to understand the mechanisms of storage and transfer of energy and matter (water, carbon...) on different scales of time and under different constraints. The new research infrastructure **E-LTER-FR RZA** (Network of research areas) which concerns the observation of socio-systems at the scale of the territories constitute with E-LTER-FR OZCAR the two French pillars of the ESFRI project E-LTER (Long Term Ecological Research Network).

BIODIVERSITY, ECOSYSTEMS

The mapping of dedicated tools shows a progressive tiling by infrastructures already well organized. The landscape is currently articulated around different tools of experimentation, of collection (archiving of samples), of analysis but also of observation.

Two experimental infrastructures make it possible to condition ecosystems and to follow the processes under controlled forcing: **AnaEE-FR NATURA** and **AnaEE -FR ECOTRONS**. Together, they constitute the French mirror of the ESFRI AnaEE.

The sample archiving infrastructures are: **RARe** bringing together the centers providing animal, plant and microbial

biological resources dedicated to agronomy and **RECOL-NAT** gathering the naturalist collections. They are part of a European system (MIRRI for microbial resources and the ESFRI project DISSCO for collections). They have strategic implications for the use of biological resources for research and development purposes.

PNDB (National Biodiversity Data Center) has the goal to give access to the observation, experimentation and collection data, in connection with the European Biodiversity Observatory Network (EU-BON) and the Global Biodiversity Information Facility (GBIF). It also allows the networking of research observatories of biodiversity.

The research questions being between "Milieux and Vivant", some infrastructures are shared with the field Biology/Health. **EMPHASIS-FR**, plant phenotyping platform, is the mirror of the ESFRI of the same name. It complements for agronomists and ecologists platforms "omics" rather part of Aviesan, such as Metabohub. A new research infrastructure for adaptive forest management **IN-SYLVA**, dedicated to large-scale experimentation and phenotyping on forests cultivated is created; it must interface with AnaEE, EMPHASIS and RARe. Two infrastructures are of great interest for the environmental sciences: on the one hand, **IBISBA-FR** for the development of synthetic biology and, on the other hand, **EMBRC-FR** (mirror of ESFRI) for living marine resources.

VIRTUAL INFRASTRUCTURE IN EARTH OBSERVATION

CIIMERI - France mission is to carry out numerical reference simulations for the World Climate Research Program (WCRP). At the national level, it aims to coordinate the major models of Météo-France and the Pierre Simon Laplace Institute (IPSL), evaluate them and produce projections of the future climate.

The **data Pole and services for the Earth system** is a planned infrastructure that aims to offer a single portal to the four clusters **AERIS**, **ODATIS**, **FORM@TER** and **THEIA** as well as new services and tools. It will manage the complete data cycle (**field measurements and satellites**) from their production till they are made available and fed into national, European and international databases (Copernicus, GEOSS...). It is expected a strong collaboration on the one hand with the Observatory of the Climate, initiative carried by the CNES, and on the other hand with the National Pole of data on the biodiversity.

 **RESEARCH INFRASTRUCTURES**
EARTH SYSTEM AND ENVIRONMENTAL SCIENCES

CATEGORY	NAME	FULL NAME	ESFRI
IO	ECMWF (CEPMMT in French)	European Centre for medium-Range Weather Forecasts	
VLRI	Concordia	Antartic Franco-Italian base	
VLRI	ECORD/IODP	European Consortium for Ocean Drilling Research/ International Ocean Discovery Program	
VLRI	EURO-ARGO	European contribution to Argo programme	EURO-ARGO (2006)
VLRI	FOF	French Oceanographic Fleet	
VLRI	ICOS France	Integrated Carbon Observation System	ICOS (2006)
RI	ACTRIS-France	Aerosols, Clouds and Trace Gases Research Infrastructure - France	ACTRIS (2016)
RI	ANAEE-France ECOTRONS	Analysis and testing of ecosystems – France ECOTRONS	ANAEE (2010)
RI	ANAEE-France Natura	Analysis and testing of ecosystems – France Natura	ANAEE (2010)
RI	ClimERI-France	Earth's Climate system Modelling	
RI	E-LTER-France OZCAR	Critical Zone Observatories, Applications and Research	
RI	E-LTER-France RZA	Social-Ecological Systems Research Infrastructure	
RI	<i>EMBRC-France¹</i>	<i>National Centre for Marine Biological Resources</i>	<i>EMBRC (2008)</i>
RI	<i>EMPHASIS France²</i>	<i>European Infrastructure for multi-scale Plant Phenomics and Simulation for food security in a changing climate (France)</i>	<i>EMPHASIS (2016)</i>
RI	EMSO-France	European Multidisciplinary Seafloor and water column Observatory - France	EMSO (2006)
RI	IAGOS-France	In-service Aircraft for Global Observing System - France	IAGOS (2006)
RI	<i>IBISBA-FR³</i>	<i>Industrial Biotechnology Innovation and Synthetic Biology Acceleration</i>	
RI	ILICO	French research infrastructure for Coastal Ocean and Seashore Observations	
RI	IN-SYLVA France	National research infrastructure for the sustainable management of the French forests	
RI	PNDB	National Biodiversity Data Center	
RI	RARE	Agronomic Resources for Research	

1 RI at the interface with the sector "Biology and Health". RI description can be found in the sector "Biology and Health".

2 RI at the interface with the sector "Biology and Health".

3 RI at the interface with the sector "Biology and Health" as well as the sector "Energy". RI description can be found in the sector "Biology and Health".

CATEGORY	NAME	FULL NAME	ESFRI
RI	RECOLNAT	Natural History Collections Network	
RI	RESIF/EPOS	French seismic and geodetic network/European Plate Observing System	EPOS (2008)
RI	SAFIRE	The French facility for airborne research	
Project	IR Système Terre	Data and services for the Earth System	

European Center for Medium-Range Weather Forecast



Category: IO

Type of infrastructure: Single site

Infrastructure location: Reading, UK

French supporting institution: Météo-France

Infrastructure representative in France:
Hervé Roquet

Construction: **Operation:**

1975

1979

Contact in France:
herve.roquet@meteo.fr

www.ecmwf.int/fr

The European Centre for Medium-Range Weather Forecasts (ECMWF) is an independent intergovernmental organisation supported by 34 Member States. The organisation was established in 1975 and now employs around 350 staff from more than 30 countries.

It is recognised as a world leader in numerical weather predictions (NWP). ECMWF is both a research institute and a 24/7 operational service, developing, producing and disseminating numerical weather predictions to its Member States. The supercomputer facility (and associated data archive) at ECMWF is one of the largest of its type in Europe and Member States can use 25% of its capacity for their own purposes. ECMWF also has an important activity in Numerical Weather Prediction, education and training. ECMWF is in charge of two Copernicus services: atmospheric environment service (CAM5) and climate change service (C3S).

ECMWF is located in Reading, UK.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Meteorology, alert services, forecasts

DATA

Estimated volume stored in 2017: 210,000 To

Estimated volume stored in 5 years: approx. +200 To/day

Data access: full

French contribution

8.2 M€ in 2016

Personnel

344 FTE in 2016 (for IO)

International dimension

ECMWF (in French CEPMMT)

Director General: Florence Rabier

Partner countries: BE, AT, DE, HR, DK, ES, FI, GR, GL, GP, HU, IE, IS, IT, MQ, ME, NO, NC, NL, PF, PT, CZ, RO

Website: ecmwf.int



CONCORDIA

Antartic Franco-Italian base

Concordia is a French-Italian polar research station located on the Antarctic continental plateau. It is the only European station at the heart of the Antarctic continent. This infrastructure includes the station itself but also all the necessary logistics chain: the vessel *L'Astrolabe*, the Annex Base Cap Prudhomme and means of transport on land, ice and snow.

Concordia was built at Dome C, a site with features unique characteristics:

- 3,200 m a.s.l.;
- average air temperature of -50 °C;
- 3,240 mm ice thickness;
- position under the polar-orbiting satellites;
- position under the polar vortex...

Concordia is a research station isolated from the rest of the world 9 months per year, hosting up to 70 researchers and technicians in summer and 14 in winter. These features enable the development of research which cannot be undertaken elsewhere and reinforce the observations of the planet on a continent of 14 million km² with only 3 inland research stations. The main objective of Concordia is to offer access to the high Antarctic plateau to the national and international scientific community in a wide range of research fields (glaciology, atmospheric physics and chemistry, astronomy, geophysics...), many of them in relation to climate change. Beyond this scientific value, Concordia has an important geopolitical role in reinforcing the French presence in Antarctica and in making it one of the main actors of scientific research on the 6th continent.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Some activities related to logistics and maintenance of the station are sources of technological developments. For instance:

- transport on ice (IPEV is leader in this field);
- waste water treatment systems (collaboration with ESA);
- renewable energies (solar energy).

DATA

The infrastructure does not store the data.

Data access: restricted

Full cost

7.6 M€ in 2016

Personnel

17 FTE in 2016

International dimension

CONCORDIA

Directors: France: Jérôme Chappellaz; Italy: Vincenzo Cincotti

Coordination countries: France, Italy

Website: www.institut-polaire.fr/ipev/infrastructures/les-bases/concordia



Category: VLRI

Type of infrastructure: Distributed

Infrastructure location: "Dome C", Antarctic on the continental plateau, 1,100 km from the French station "Dumont d'Urville"

French supporting institution: IPEV

Director: Jérôme Chappellaz

Construction: **Operation:**

2005

2005

Contact in France:

dirpol@ipev.fr

www.institut-polaire.fr/ipev/infrastructures/les-bases/concordia

European Consortium for Ocean Research Drilling



Category: VLRI

Type of infrastructure: Distributed

Infrastructure location: Aix-en-Provence

Other sites: Montpellier, Toulouse

French supporting institution: CNRS

Director: Gilbert Camoin

Construction: **Operation:**

2003

2018

Contact in France:
camoin@cerege.fr

www.iodp-france.org

ECORD is a European consortium which is involved in IODP (International Ocean Discovery Program; 23 countries) and provides to the French science community the opportunity to get access to three primary platforms in an international program:

- the National Science Foundation (NSF) operates the US-supplied multi-purpose drillship JOIDES Resolution;
- the Japanese Agency for Marine-Earth Science and Technology (JAMSTEC) operates the riser-drilling-capable Chikyu for ultra-deep drilling in the ocean crust, the underlying mantle, and subduction zone environments;
- ECORD operates Mission-Specific Platforms (MSP) chartered on a specific project basis for drilling in technically challenging conditions, including high latitudes and shallow-water environments.

The MSP concept has now been extended to other drilling systems (seabed drills, long piston coring, etc.) which are cheaper than conventional drill ships and better adapted to certain types of environments and operations.

Scientific ocean drilling and associated techniques are essential tools to understand and predict the functioning of the Earth system. IODP highlights four main scientific themes:

1. climate and Ocean Change: Reading the Past and Informing the Future;
2. biosphere Frontiers: Deep Life, Biodiversity, and Environmental Forcing of Ecosystems;
3. deep Processes and Their Impact on Earth's Surface Environment;
4. earth in Motion: Processes and Hazards on Human Time Scales.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The scientific drillship provides essential data for different industry sectors (petrol industry, biotechnologies, etc.). ECORD and IODP innovate in technological developments concerning materials and drilling techniques in collaboration with industry (big industrial groups and SME) and competitive poles.

DATA

Estimated volume stored in 2017: 500 To

Estimated volume stored in 5 years: 1,000 To

Embargo period: 12 mois

Data access: full

Full cost

4.6 M€ in 2016

Personnel

4 FTE in 2016

International dimension

ECORD et IODP

Director: Gilbert CAMOIN (ECORD)

Coordinating country: France

Partner countries: AU, AT, DE, BR, CA, CN, KR, DK, ES, US, FI, IN, IE, IT, JP, NO, NZ, NL, PT, UK, SE, CH

Website: www.ecord.org et www.iodp.org



EURO-ARGO

European contribution to ARGO program

Argo is an international infrastructure of about 4,000 profiling floats that measure temperature and salinity throughout the global oceans, down to 2,000 meters. Argo is the first-ever global, in-situ ocean-observing network in the history of oceanography, providing an essential complement to satellite systems, to observe, understand and predict the ocean and its role on the earth's climate. The main objectives of Argo are to consolidate and sustain the existing network for the next 10 to 20 years.

Characterization of climate change and of the fundamental role of the ocean on climate requires long term observations. The network will also have to evolve: coverage of polar areas and marginal seas, technology improvements, extension to deeper depths and to biogeochemical sensors. In that context, the objective of Euro-Argo is to organize the contribution of its members to allow Europe to:

- deploy, maintain and operate a network of at least 800 floats which requires deploying every year at least 250 floats;
- provide a state-of-the art service to the research (ocean, climate) and operational oceanography (Copernicus Marine Service) communities;
- prepare and contribute to the new phase of Argo with an extension to biogeochemical parameters, the deep ocean and Polar Regions.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Euro-Argo organises and develops the European contribution to Argo. Considering the importance of Argo for Climate research, seasonal and decadal forecasting activities, the socio-economic impacts should be important on the long term. At French level, the Euro-Argo ERIC development fostered the SME NKE as the first Argo profiling float manufacturer in Europe.

DATA

Estimated volume stored in 2017: 5.5 To

Estimated volume stored in 5 years: 10 To

Data access: full

Full cost

2.9 M€ in 2016

Personnel

10.2 FTE in 2016

International dimension

ERIC Euro-Argo, ESFRI Landmark

Coordinator: Sylvie Pouliquen

Coordinating country: France

Partner countries: BU, DE, ES, FI, GR, IE, IT, NO, NL, PL, UK

Website: www.euro-argo.eu



Category: VLRI

Type of infrastructure: Distributed

Infrastructure location: Plouzané

Other sites: Villefranche-sur-Mer, Paris

French supporting institution: IFREMER

Coordinator: Sylvie Pouliquen

Construction: **Operation:**

2014

2014

Stakeholders in France: CNRS, Sorbonne Université

Contact in France:

sylvie.pouliquen@ifremer.fr

www.naos-equipex.fr

French Oceanographic Fleet



Category: VLRI

Type of infrastructure: Distributed

Infrastructure location: Toulon, Brest

French supporting institution: IFREMER

Director: Olivier Lefort

Construction: **Operation:**

2007

2007

Contact in France:

olivier.lefort@ifremer.fr

www.flotteoceanographique.fr

The fleet involves:

- 4 offshore vessels: *Marion Dufresne*, *Pourquoi pas ?*, *L'Atalante*, *Thalassa*;
- 2 ships positioned overseas: *Alis*, *Antea*;
- 5 coastal vessels used in the Channel-Atlantic and Mediterranean: *Thetys*, *L'Europe*, *Thalia*, *Côtes de la Manche*, *Haliotis*;
- 7 station vessels, spread across all metropolitan coastlines, can achieve missions during one to three days;
- submarines: *Nautile* (manned submersible), remotely operated robot *Victor 6000*, AUV;
- scientific instruments: seismic, Penfeld penetrometer, corer.

It can carry scientific research and long term observations in marine environmental sciences: geosciences, physical and biological oceanography, geochemistry and organic chemistry, paleoclimatology, marine biodiversity, etc. It participates in the education of students for the marine universities. It contributes to public service mission, monitoring and expertise.

Types of operations and observations:

- physico-chemical measurements in the water column;
- continuous monitoring (meteorology, current measurements, geophysics...);
- bathymetry, mapping, seismic;
- sampling and analysis of samples (water, fauna, flora), sediment coring up to 70 meters deep;
- installation and maintenance of seafloor observatories.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

For a significant part of its activity, the fleet also fulfils the needs of surveillance, expertise or public service on behalf of the French authorities (hydrographic campaigns, coastal environment, and fishery stock assessment). The fleet is also involved in research-industry partnerships, particularly in the fields of mineral and energy resources.

DATA

Embargo period: 24 months

Data access: restricted

Restrictions: regarding the geosciences, access is particularly framed, while in other areas it is more open.

Full cost

—
92.2 M€ in 2016

Personnel

—
159.8 FTE in 2016

Integrated Carbon Observation System – France

ICOS is a distributed research infrastructure providing harmonized measures at the European level on the carbon cycle, emissions and atmospheric concentrations of greenhouse gases. The ICOS research mission is to provide scientists with the observations needed to better understand the exchanges of greenhouse gases and to predict the future behavior of carbon sources and sinks. The major objective of ICOS is to measure the long term essential parameters of the main greenhouse gases cycle. Such data are requested for the understanding of greenhouse gas fluxes (natural or anthropogenic) and the multi-scale processes that determine them. ICOS will also detect the temporal changes in regional greenhouse gas fluxes, measure the impact of extreme weather events and of emission reduction policies and will reduce uncertainties in Earth system models and their predictions. ICOS integrates networks of stations in the atmosphere, over land ecosystems and the ocean to establish the budget of greenhouse gases in Europe. Each network is coordinated by its Thematic Center (TC) responsible for the centralized data processing and quality control. ICOS-Fr is an essential contributor to ICOS. The Atmosphere Thematic Centre is led by France, the Ecosystem Thematic Centre by Italy-France-Belgium and the Ocean Centre by Norway. The calibration center based in Germany provides the reference gases for the networks and perform analysis of air samples collected in flasks. The headquarters are based in Finland and the data portal is located in Sweden.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The BRIDGES program (CH₄ emissions) was implemented with Veolia and Thales Alenia Space (2012-16). The consortium TRACE (trace.lscce.ipsl.fr, ANR-Suez-Thales-Alenia Space-Total) was launched by ICOS-France in 2018. The Ecosystem stations have developed partnerships with agronomy and forest industries (CNPf, ONF, ALLIANCE, RMT AFORCE), the ATC with gas analyzer manufacturers (SMEs and laboratories) and ICOS-France for developing the use of data (Airbus, ARIA Technologie, KIC-Climat).

DATA

Estimated volume stored in 2017: 15 To

Estimated volume stored in 5 years: 75 To

Data access: full

Full cost

6.3 M€ in 2016

Personnel

49.2 FTE in 2016

International dimension

ICOS, ESFRI Landmark

Director: Werner Kutsch

Coordinating country: Finland

Partner countries: BE, DK, DE, FR, GL, GF, IT, NO, NL, PT, CZ, UK, RO, SE, CH, HU

Website: www.icos-ri.eu



Category: VLRI

Type of infrastructure: Distributed

Infrastructure location: Villenave d'Ornon

Other sites: CEA, CNRS, UVSQ, LSCE, Gif-sur-Yvette, ANDRA Châtenay-Malabry

French supporting institution: ANDRA, CNRS, CEA, INRA, UVSQ

Coordinator: Denis Loustau

Construction: Operation:

2008

2016

Stakeholders in France: AgroParisTech, CIRAD, CNES, IFREMER, IRD, École pratique des Hautes Études, MétéoFrance, Montpellier Sup-Agro, Universités des Antilles, Avignon, Grenoble-Alpes, Guyane, Lorraine, Orléans, Paul Sabatier, Paul Valéry Montpellier, Montpellier, Reims, Sorbonne Université, Paris-Sud, OSU: OVSQ, OMP, OPGC, OSUR, PyTHEAS

Contact in France:

denis.loustau@inra.fr

icos-france.fr

Aerosol, Cloud and Trace Gases Research Infrastructure – France



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Paris, Gif-sur-Yvette, Grenoble, Clermont-Ferrand, Lille, Créteil, Saint-Denis-La Réunion, Saint-Michel-l'Observatoire, Lannemezan-Pic-du Midi, Toulouse, Peyrusse, Vielille, Tardière, Orléans, Villeurbanne, TAAF, Chacaltaya (Bolivia), Lamto (Ivory Coast)

French supporting institution: CNRS

Director: Paolo Laj

Construction: Operation:

2016

2025

Stakeholders in France: CNES, CEA, IRD, IPEV, INERIS, Météo-France, AMU, ENPC, EP, IMT, SU, UCA, UGA, UR, UPS, UVSQ, Université Lille 1, UPD, UPEC

Contact in France:

paolo.laj@univ-grenoble-alpes.fr

www.actris.fr

ACTRIS is the pan-European initiative for the observation of atmospheric aerosols, clouds, and trace gases and for the exploration of their interactions. ACTRIS is a distributed research infrastructure that supports research in the fields of climate change and air quality delivering data, services and procedures for improving the current capacity to analyze, understand and predict past, current and future evolution of the atmospheric environment.

ACTRIS will provide the 4D-variability of the properties of short-lived atmospheric species from the troposphere to the stratosphere, with the required level of precision, coherence and integration together with the means for understanding and efficiently using the complex and multi-scale information from operating atmospheric simulation chambers.

ACTRIS serves a vast community of users working on models, satellite retrievals, and analysis and forecast systems, and offers access to advanced technological platforms for exploring the relevant atmospheric processes and for technological innovation.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

A socio-economic impact analysis can only be performed at the European level. A preliminary study carried out in 17 countries confirms a high, worldwide, socio-economic impact and significant data use. It shows that the investment in the RI generates substantial added value with respect to human capital (international mobility, PhD students), knowledge (>300 articles/year), and innovation (12 start-ups created, of which 1 is in France; 129 companies are involved, of which several are French).

DATA

Estimated volume stored in 2017: 100 To

Estimated volume stored in 5 years: 1,000 To

Data access: full

Full cost

7.2 M€ in 2016

Personnel

48.3 FTE in 2016

International dimension

ACTRIS, ESFRI Project

Coordinators: Markku Kulmala, Sanna Sorvari

Coordinating country: Finland

Partner countries: CY, ES, GR, IT, NL, PL, CZ, RO, UK, DE, BU, DK, NO, FR

Website: www.actris.eu

ANAEE-FR ÉCOTRONS

ANAEE-FR ECOTRONS



Maintaining ecosystem services, including food production, is a priority issue that requires rapid progress in our understanding of ecological systems. To meet these challenges, the ANAEE-FR ECOTRONS RI provides a broad national and international scientific community (ecology, agronomy, biology, geosciences), with 5 experimental platforms for terrestrial and aquatic environments that constitute a conceptual and technological leap forward compared to observation and experimentation tools developed in natura. Ecosystem properties are determined by the interactions between the living world, or biodiversity, and the abiotic compartments of the soil and atmosphere. To dissect these interactions, the Ecotrons enable regular or model organisms as well as intact, simplified or artificial ecosystems to be subjected to a wide range of environmental conditions. Simultaneously to this conditioning, the Ecotrons measure, on line when possible, the multiple responses of these organisms or ecosystems. Unique on an international level in terms of its human, technical and financial resources, the ANAEE-FR ECOTRONS RI contributes to finding solutions to environmental problems through research at ecosystem level (alteration of biogeochemical cycles, role of biodiversity, etc.) as well as at the level of organisms and populations (epigenetics, evolution, physiology of organisms, community biology, etc.). The ANAEE-FR ECOTRONS RI contributes to the ERIC AnaEE project, included in the ESFRI roadmap, and to the development of a European network of Ecotrons.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The ANAEE-FR ECOTRONS RI contributes to major societal challenges resulting from global changes and in particular unravels their impact on the maintenance of ecosystem services, food security and biodiversity. The RI does this by hosting researchers from the public and private sectors (10%) who study ecosystems (understanding of mechanisms for proposing and testing global changes mitigation and adaptation options) and organisms and populations (physiology, genetics, epigenetics, etc.).

DATA

Estimated volume stored in 2017: 8 To

Estimated volume stored in 5 years: 16 To

Embargo period: 36 months

Data access: full

Full cost

3.4 M€ in 2016

Personnel

12.6 FTE in 2016

International dimension

AnaEE, ESFRI project

Director: Michèle Tixier-Boichard

Coordinating country: France

Partner countries: BE, DK, IL, CZ, IT, UK

Website: www.anaee.com



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Montferrier-sur-Lez

Other sites: Saint-Pierre-lès-Nemours

French supporting institution: CNRS

Coordinator: Jacques Roy

Construction: Operation:

2010

2011

Stakeholders in France: ENS ULM,
Université de recherche PSL

Contact in France:

jacques.roy@ecotron.cnrs.fr

[www.cnrs.fr/inee/outils/
ecotrons.htm](http://www.cnrs.fr/inee/outils/ecotrons.htm)

ANAEE-FRANCE NATURA

Analysis and testing of ecosystems – France



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Saint-Pierre-lès-Nemours

Other sites: Montferrier-sur-Lez, Rennes, Moulis, Lusignan, Clermont-Ferrand, Theix, Mons-en-Chaussée, Thiverval-Grignon, Colmar, Le Rheu, La Réunion Sainte-Marie, Azeraille, Breuil, Nancy, Montiers, Avignon, Montpellier, St Michel l'Observatoire, Nouragues (Guyana), Itatinga (Brasil), Cartago (Costa Rica), Chachoengsao (Thailand), Grenoble, Lautaret, Thonon-les-Bains, Dijon, Versailles, Orléans, Paris

French supporting institution: CNRS, INRA, UGA, CIRAD, IRSTEA, ENS ULM

Director: Jean-François Le Galliard

Construction: Operation:

2012

2016

Stakeholders in France: ANDRA, IRD, CIRAD, IRSTEA UCA, Université de Bourgogne, Université de Guyane, Université de Montpellier, Université de Rennes 1, Université de Savoie, Université de Toulouse 3 – Paul Sabatier

Contact in France:
cereep@biologie.ens.fr

www.anaee-france.fr/fr

Understanding the response of ecosystems to global changes is a major scientific and societal challenge. From this perspective, it is necessary to be able to manipulate ecosystems to characterize their properties and the complexity of the interactions at work, and develop a fundamental knowledge corpus necessary for the implementation of adaptation and restoration measures. The AnaEE-France Natura (Analysis and Experimentation on Ecosystems) infrastructure meets these objectives by providing a coherent raft of services dedicated to experimentation for the study of continental ecosystems in natura, analysis and modelling.

The RI facilitates the use of experimental platforms, the emergence of innovative projects and the reuse of data. It brings together 32 installations on a national scale to study ecosystems in natura, in particular through contrasting management methods likely to generate different long-term trajectories. Ecosystem characterization capacity is increased within the infrastructure through the provision of 9 analytical services for recording variables related to biological organisms, soil and biodiversity, and matter flows. The RI provides an information system enabling the advanced integration of databases and their coupling with modelling platforms. AnaEE-France Natura is the French node of the AnaEE ERIC project included within the ESFRI roadmap.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Each year the infrastructure hosts approximately 10% collaborative projects with private operators. Specific attention is devoted to the treatment of industrial projects in each installation's charter. The benefits include ecological engineering, mitigation and adaptation to global change scenarios, food security and the supply of renewable resources for the bio-economy.

DATA

Estimated volume stored in 2017: 50 To

Estimated volume stored in 5 years: 100 To

Embargo period: maximum 24 months

Data access: full

Full cost

18.0 M€ in 2016

Personnel

136.0 FTE in 2016

International dimension

AnaEE, ESFRI Project

Coordinators: Michèle Tixier Boichard, Jacques Roy

Coordinating country: France

Partner countries: BE, DK, IL, CZ, IT, UK

Website: www.anaee.com

CLIMERI-FRANCE

France National Earth climate system modelling research infrastructure

CLIMERI-France is the national infrastructure for Earth System Climate Modelling. Its mission is to perform numerical simulations for the World Climate Research Programme and to provide the results to different users' communities. These coordinated experiments aim to understand the climate system, to evaluate climate models through the definition of standard experiments, to enable process studies, and to produce projections of the future evolution of climate. These experiments constitute the science basis of the IPCC Reports.

CLIMERI-France encompasses the human resources enabling development, testing and maintenance of models and modelling tools, benchmarking of codes, exploitation of results, the computing resources allowing the realization of the international experiments and associated data archiving, in part provided by the national computing infrastructure GENCI, as well as the software infrastructure for data and metadata control and management.

The infrastructure provides model codes and software tools and offers data access and analysis services for results of global and regional models. The simulations serve as a reference for the emerging climate services at national level, as well as for the Copernicus climate change service at European level.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

CLIMERI-France prepares and provides data from the reference simulations performed with the French climate models. These data are used within IPCC Assessment Reports and for climate impact studies in different socio-economic sectors (agriculture, energy, water, health, insurance...). They serve as a reference for climate services, in particular within the Copernicus Climate Change Service, and SMEs.

DATA

Estimated volume stored in 2017: 1,000 To
Estimated volume stored in 5 years: 10,000 To
Data access: full

Full cost

11.1 M€ in 2016

Personnel

61.2 FTE in 2016

International dimension

IS-ENES

Coordinator: Sylvie Joussaume

Coordinating country: France

Partner countries: DE, DK, ES, IT, NO, NL, RO, UK, SE

Website: is.enes.org



Category: RI

Type of infrastructure: Virtual

Infrastructure location: Gif-sur-Yvette

Other sites: Toulouse, Paris, Bruyères-le-Châtel, Orsay

French supporting institution: CNRS, CEA, Météo-France

Coordinator: Sylvie Joussaume

Construction: **Operation:**

2017

2017

Stakeholders in France: RD, UPMC, SU

Contact in France:

sylvie.joussaume@lsce.ipsl.fr

climeri-france.fr

E-LTER-FRANCE OZCAR

Critical Zone Observatories, Applications and Research



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Grenoble, Rennes, Toulouse, Strasbourg, Lyon, Montpellier, etc.

French supporting institution: CNRS, IRD, INRA, IRSTEA, BRGM

Coordinators: Jérôme Gaillardet, Isabelle Braud

Construction: **Operation:**

2015

2015

Stakeholders in France: ANDRA, CNES, Ifsttar, IPEV, Météo-France, IPG, Université d'Avignon et des Pays de Vaucluse, Université Bourgogne – Franche-Comté, Université de Bordeaux, UBO, UGA, Université de La Réunion, UDL, Université d'Orléans, Université Paris Diderot, UPMC, Université de Rennes 1, Université de Rouen Normandie, Université de Savoie-Mont Blanc, Université de Strasbourg, Université Toulouse, INPT, Mines Télécom, VetAgroSup

Contact in France:

gaillardet@ipgp.fr

isabelle.braud@irstea.fr

www.ozcar-ri.org

ELTER-FR Ozcar is a distributed research infrastructure gathering instrumented sites on continental surfaces (critical zone) where soil, subsoil, water or ice is continuously monitored in order to measure and to model the cycles of water, carbon and associated elements. The major scientific issues concerns a better understanding of stocks and flows of matter on inland surfaces along various gradients (climatic, topographic, geological and land use).

ELTER-FR Ozcar is a research infrastructure essential for an enlarged and consolidated vision of environmental changes occurring on continental surfaces at the territorial level. It gathers research observatories of national research Institutions. The Research Infrastructure had a common governance and methodology at the service of studying the functioning and evolution of the critical zone for scientific research, support for public policies and for the economic world.

The research infrastructure is focused on: watersheds, hydrometeorology, aquifers, natural and anthropogenic soils (agrosystems, industrial wastelands, cities), coastline, wetlands, snow-covered and ice-covered areas. Collaboration is established with socio-economic and institutional organizations such as competitiveness Poles, industries in relation with resources, storage and risks.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

ELTER-FR Ozcar is working with the stakeholders as it is concerned by the water, soil, biodiversity resource. Socio-economic impact lies in the development of new environmental sensors and the production of data allowing us to monitor the environment at the territory level, in response to environmental changes.

DATA

Estimated volume stored in 2017: 1-10 To

Estimated volume stored in 5 years: 10-50 To

Embargo period: 48 months on average

Data access: restricted

Restrictions: most of the data are accessible, but not all with dedicated data portals, due to limited human resources. The Theia/OZCAR data/metadata portal that is under construction will render the data accessible.

Full cost

15.2 M€ in 2016

Personnel

121.6 FTE in 2016

International dimension

E-LTER

Coordinator: Michael Mirtl

Coordinating country: Germany

Partner countries: AT, BE, BU, DK, ES, FI, GR, IL, IT, PT, CZ, UK, RS, SK, SI, CH, TR

Website: www.lter-europe.net/lter-europe

E-LTER-FRANCE RZA

Social-Ecological Systems Research Infrastructure – FRANCE



The eLTER-FR RZA RI is a distributed infrastructure for the long-term observations of interactions between humanity and nature within a common conceptual framework and with a cross-cutting scientific culture; it is designed to offer a coordinated and coherent research operation, based on regional mechanisms and observatories. It offers a diversity of contrasting and complementary situations from the point of view of the ecosystems and social systems studied. The RI is organized around a structural research question, supported by hypotheses, a theoretical formalism and an operational framework common to all ZAs. Tools, approaches and methodologies specific to the systems studied are deployed and adapted. The theoretical framework of the RI research problem is the description, understanding and prediction of the response of anthropic ecosystems to global change, to formalize and theorize the functioning of socio-ecosystems, and to assist in their management and governance. The multidisciplinary and interdisciplinary research coordinated by the RI includes long-term observation of landscapes, practices, biodiversity or ecosystem flows. The questions addressed in the ZAs are in direct contact with stakeholders in the regions and with questions arising from the world of managers, politicians and NGOs. The system, as set up and coordinated, is open to national or international research communities other than those involved in the concerned ZA.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The RI plays a structural role with respect to territorial authorities, regional offices of State Departments, managing bodies and agencies, and the private sector. This RI will allow to transfer the European or National political decisions towards the various ZAs, allowing to implement these decisions in tandem with the stakeholders at a regional level. The RI guarantees continuity of action, from Europe to the Regions, through implementing an interdisciplinary approach to promote the sustainability of regions.

DATA

Estimated volume stored in 2017: 1 Mo. The ZAs data and metadata written within the applicable standards (Inspire, INPN, GBIF, GEOBON, LIFEWATCH, etc.) are available through a portal built with the help of the 'UMS 3468 BBEEES (CNRS, MNHN) and hosted by the IN2P3 computing center of Lyon.

Estimated volume stored in 5 years: 10 Mo. The ZAs data and metadata written within the applicable standards (Inspire, INPN, GBIF, GEOBON, LIFEWATCH, etc.) will be made available through a portal built with the help of the 'UMS 3468 BBEEES (CNRS, MNHN) and hosted by the IN2P3 computing center of Lyon.

Data access: restricted

Restriction: Data accessibility is governed and managed by each ZA. An incentive openness policy is currently being drafted by the RI.

International dimension

E-LTER

Coordinator: Michael MIRTIL

Coordinating country: Germany

Partner countries: AT, BE, DE, BU, DK, ES, FI, GR, IL, IT, PT, CZ, UK, RS, SK, SI, CH, TR

Website: www.lter-europe.net/lter-europe



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Grenoble, Saint-Pée-sur-Nivelle, Rennes, Villeurbanne, Plouzané, Strasbourg, Besançon, Tours, Vandœuvre-lès-Nancy, Beauvoir-Sur-Niort, Aubières, Castanet Tolosan

French supporting institution: CNRS

Coordinator: Vincent Bretagnolle

Construction: Operation:

2006

2018

Stakeholders in France: INRA

Contact in France:

vincent.bretagnolle@cebc.cnrs.fr

www.za-inee.org

European Infrastructure for multi-scale Plant Phenomics and Simulation for food security in a changing climate – France



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Montpellier

Other sites: Clermont-Ferrand, Castanet-Tolosan, Dijon, Beauce la Romaine, Villenave d'Ornon, Nantes, Mauguio, Bretenières, Beaucauzé, Auzeville

French supporting institution: INRA

Coordinator: François Tardieu

Construction: Operation:

2012

2012

Stakeholders in France: Arvalis Institut du Végétal Terres Inovia (in development), CEA

Contact in France:

francois.tardieu@inra.fr

www.phenome-fppn.fr

EMPHASIS FRANCE develops facilities for characterizing hundreds of genotypes under environmental scenarios of climate changes, and a suite of methods for organizing, storing and analyzing resulting datasets. (i) 4 platforms in controlled conditions for in-depth analysis of leaf or root system under ranges of water deficits, CO₂ concentration and temperature; (ii) 2 field platforms with large rainout-shelters and one free-air carbon enrichment system; (iii) 3 equipped field platforms with high throughputs. (iv) 2 omic supporting platforms (metabolism and structure). All platforms can cope with 200-300 genotypes and manipulate/control environmental conditions. They are equipped with a consistent set of 3D functional imaging techniques, detailed imaging of roots and shoots in controlled conditions and canopy imaging with a 'phenomobile' and drones in the field. Platforms are accessible to public and private partners via the project website. Applications with technological jumps are developed at infrastructure level, with partnerships with French SMEs. They (1) improve our capacity to measure plant traits and environmental conditions in field and platforms (2) organize phenotypic data originating from all Phenome platforms; (3) handle very large datasets via machine learning, analyses of time-related data and development of an interface with plant and crop models. An ecosystem of SMEs has developed around EMPHASIS France, which also coordinates a European I3 project (EPPN2020) and has a major role in the preparatory phase for a European ESFRI infrastructure (EMPHASIS).

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

A network of French SMEs is developing around Emphasis France. A spin off has been created in 2014, HiPhen for UAV solutions. Two other spin off are in "incubators", MEAS-IT for specific sensors and Phymea for imaging and modelling. Capt-Connect has developed wireless data transmission system. Inoviaflow has patented and commercializes new generation high throughput rhizotrons. Meca3D and Robopec have developed and commercialize the Phenomobile V2. Emphasis France interacts with the major seed companies

DATA

Estimated volume stored in 2017: 500 To

Estimated volume stored in 5 years: 2,000 To

Embargo period: according to the EU or national project consortium agreement. 10 years maximum for private access.

Data access: full

Full cost

8.5 M€ in 2016

Personnel

55.1 FTE in 2016

International dimension

EMPHASIS, ESFRI project

Coordinator: Uli Schurr

Coordinating country: Germany

Partner countries: BE, IT, NL, UK

Website: emphasis.plant-phenotyping.eu

European Multidisciplinary Seafloor and water column Observatory – France

The infrastructure is constituted on each site of underwater observation data collecting equipments (physical, chemical and biological sensors, cameras...) and either cable links or combined acoustic/buoy/Hertzian links to the coast allowing real time or near real time data transmission. A cooperation of data centers in Brest (IFREMER), Bremen (Pangea) and Rome (INGV) provides an open access to data through disciplinary portals and real time access. EMSO network aims at acquiring time series in deep seas for the following main scientific objectives:

1. seismic, volcanic, hydrothermal and gravity processes and potentially associated risks;
2. study deep marine ecosystem for fundamental research but also sustainable management with respect to anthropogenic and climatic drivers;
3. contribute to global change monitoring by acquisition of Eulerian data along the water column;
4. promote developments of marine technologies working under high pressure.

The sites financially supported by EMSO France are: Marmara Sea (under preparation), Azores (operating, technology update in 2016-17) and Ligurian Sea (operating, extension Nice in 2015 and MEUST in 2018-19). The Research Infrastructure includes the common functions of the network. The underwater nodes host monitoring instrumentation for all disciplines.



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Plouzané, Villefranche-sur-Mer France, Valbonne, La Seyne-sur-Mer Cedex, Marseille Sites instrumentés: Mer Ligure, Açores, Marmara (en préparation) et site d'essai en mer d'Iroise

French supporting institution: CNRS, IFREMER

Coordinator: Mathilde Cannat

Construction: Operation:

2014

2014

Contact in France:
cannat@ipgp.fr

www.emso-fr.org/EMSO-France

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Industrial opportunities to provide fixed cabled or relocatable infrastructures, connected instruments, to create data bases and associated services. The targeted market is that of monitoring before and during the production of oil fields, Deep-Sea mining and marine renewable energy. Promoting SMEs is ensured by the 2 "Pôles Mer". EMSO France Essential Ocean and Climate Variables feed UNEP/GEO, IPCC, OSPAR, and the DCSSM.

DATA

Estimated volume stored in 2017: 0.5 To

Estimated volume stored in 5 years: 10 To

Embargo period: for some data an embargo of 3 years maximum is established.

Data access: full

Full cost

2.6 M€ in 2016

Personnel

11.7 FTE in 2016

International dimension

EMSO, ESFRI Landmark

Director: Juanjo Dañobeitia

Coordinating country: Italy

Partner countries: ES, GR, IE, PT, RO, UK, FR, IT

Website: www.emso-eu.org

In-service Aircraft for a Global Observing System



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Toulouse

French supporting institution: CNRS, Météo-France

Coordinator: Valérie Thouret

Construction: Operation:

2014

2011

Stakeholders in France: Université de Toulouse 3 – Paul Sabatier

Contact in France:

valerie.thouret@aero.obs-mip.fr

www.iagos.org
(section data portal)
or directly via
www.iagos-sedoo.fr

IAGOS is a European research infrastructure, which aims to provide the densest in-situ database with high spatial and temporal resolution over several decades to monitor the evolution of the atmospheric composition regarding climate change and air quality. The goal is to establish, operate, and analyse a global long-term observation network for reactive trace gases (ozone, carbon monoxide, nitrogen oxides), greenhouse gases (water, carbon dioxide, methane, ozone), aerosols and cloud particles (water droplets and ice crystals).

The global coverage is provided by a fleet of passenger aircraft (Airbus A340/A330) owned by international airlines. These observations are exploited by international scientific networks, weather prediction and air quality prediction centers, the Copernicus Atmosphere Monitoring Service (CAMS), and more broadly by the Global Earth Observation System of Systems (GEOSS). IAGOS benefited from the experience acquired during MOZAIC started in 1994.

In 2017, the database includes more than 55,000 flights covering already more than 23 years. IAGOS has demonstrated that the commercial aircraft is the ideal platform for long-term in-situ measurements in the most critical atmosphere zone with respect to the greenhouse effect (upper troposphere - lower stratosphere, 9 -13 km altitude at mid latitudes). IAGOS also provides vertical profiles throughout the troposphere which are of major interest for air quality issues.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

In France, some of IAGOS activities are carried out by aeronautical subcontractors in the Occitanie and Aquitaine regions: industrialization of the production of instruments by LGM, certificates of airworthiness by Sabena-Technics. In Germany, two aeronautical subcontractors are also involved: enviscope, GmbH and Gomolzig Flugzeug und Maschinenbau (GFM) involved in the maintenance, logistics and certification of on-board instruments.

DATA

Estimated volume stored in 2017: 1 To

Estimated volume stored in 5 years: 1,2 To

Data access: full

Full cost

1.7 M€ in 2016

Personnel

9.8 FTE in 2016

International dimension

IAGOS, ESFRI Landmark

Coordinator: Andreas Petzold

Coordination countries: Germany, France

Partner countries: UK

Website: www.iagos.org

French research infrastructure for Coastal Ocean and Seashore Observations

The coastal ocean and seashore areas, at the interface between the land surfaces and the open ocean, are significant zones of transfer and exchange. Crucial transformations, especially through living-mineral interactions, and changes in the littoral and marine coastal ecosystems are taking place in this environment which is evolving at different spatial and temporal scales. The understanding of the physical, biogeochemical and sedimentary processes are fundamental. The observation of marine coastal and sea shore ecosystems through a set of various multidisciplinary parameters is necessary. Such an observation needs therefore measurements, via sensors and collected samples, at the relevant spatial and frequency resolutions, to characterize the long-term evolution of marine coastal and littoral environments. This monitoring will also lead to the understanding and forecasting of various processes and of the impact of extreme events.

The RI has the following tasks:

1. ensure that the observations in the coastal and littoral environments meet the societal and scientific issues;
2. federate the network of observation infrastructures in a multidisciplinary approach;
3. guarantee interoperability and quality of the various observations.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

There is a strong interest of the French local and national authorities as well as many local partners for the observations carried out under the ILICO Infrastructure regarding ecosystem health (incl. coral reef Health), water quality, coastal risks, climate changes, at different scales.

Partnerships are also built with industry key-players to promote joint-developments of new sensors or innovative acquisition platforms.

DATA

Estimated volume stored in 2017: 0.5 To

Estimated volume stored in 5 years: 10 To

Embargo period: for certain data maximum up to 3 years, during the qualification period.

Data access: full

Full cost

10.6 M€ in 2016

Personnel

91.3 FTE in 2016



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Brest

Other sites: More than 300 observatory sites

French supporting institution: CNRS, IFREMER

Directors: Christophe Delacourt, Jérôme Paillet

Construction: Operation:

2016

2016

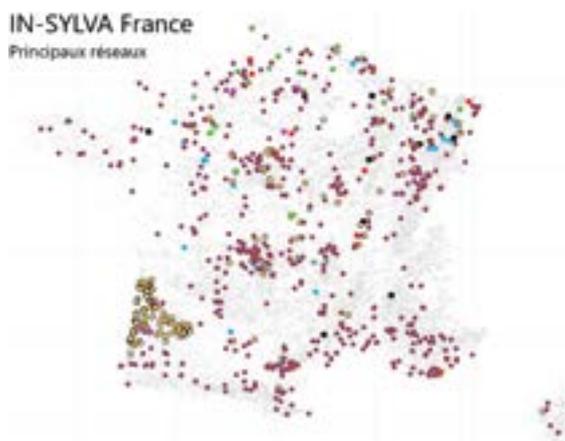
Stakeholders in France: Maritime universities network, IRD, SHOM, IGN, CEREMA, BRGM

Contact in France:
direction@ir-ilico.fr

www.ir-ilico.fr

IN-SYLVA FRANCE

National research infrastructure for the sustainable management of the French forests



IN-SYLVA-France is a research infrastructure that contributes to the responses to socio-economic and environmental challenges mentioned in the National Forest Plan (PNFB): i/ adaptation of forests to global changes, ii/ creation of jobs through silvicultural innovation and iii/ upstream to downstream adequacy in the forestry wood chain. IN-SYLVA feeds academic and applied research in the field of forest science. Its originality is to combine the silvicultural, biogeochemical and genetic levers to promote an integrated vision of silviculture and to develop an adaptive and sustainable management of forests, so that they can provide the ecosystem services they underpin. Silviculture, which regulates stand population, soil fertility, and microclimate, determines the evolution of genetic diversity, one of the fuels of adaptive capacity. IN-SYLVA provides services to all the users (academic and managers) of the "Programme national de la forêt et du bois" and federates the experimental networks studying the interactions between practices x genetic resources x environment, in more than 4,000 ha of experimentation (3,000 sites in France). IN-SYLVA also integrates analytical platforms in functional ecology, biogeochemistry, xyloscience, and genetics to characterize climate, soils and plant material in a high-throughput manner. IN-SYLVA aims at promoting research projects on sustainable forest management. It will support a portal to bring network details to the attention of the scientific community and the public. A data access charter will provide the conditions for accessing to and using the data.

Category: RI

Type of infrastructure: Distributed

Infrastructure location: Champenoux

Other sites: Nancy, Orléans, Bordeaux, Avignon, Toulouse, Fontainebleau, Compiègne, Chambéry, Avignon, Dôle, Champs-sur-Marne, Cestas, Charrey-sur-Saône, Verneuil-sur-Vienne, Grenoble, Nogent-sur-Vernisson, Grenoble, Aix-en-Provence, Montpellier, Birieux, La Petite Pierre, Trois-Fontaines, Arc-en-Barrois, Paris, Toulouse, Lyon, Orléans

French supporting institution: INRA

Coordinator: Laurent Saint-Andre

Construction: Operation:

2018

2018

Stakeholders in France: CIRAD, IRSTEA, ONF, FCBA, CNPF, ONCFS

Contact in France:

laurent.saint-andre@inra.fr

www6.inra.fr/in-sylva-france

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

In-Sylva France is built on the upstream forest-wood sector for the adaptation of forests to global changes and their ability to provide multiple services. The economic actors in these sectors, such as the ONF and the federation of the private managers (CNPF), are integrated into the infrastructure through their research and development services. With these partners, it is the majority of private and public actors in the forest upstream that have access to infrastructure services.

DATA

Estimated volume stored in 2017: 25 To

Estimated volume stored in 5 years: 250 To

Embargo period: Free access to data that do not suffer from limitations (ex: private financing, personal data...) will be effective as soon as the outcome of the phases of acquisition and curation of these data and will be carried out in the context of the projects that produce them. However, in order to allow a first valuation of data by their direct producer, an embargo of a maximum duration of 2 years after the end of the research project can be requested subject to be argued (ex: ongoing thesis, analysis of a temporal series...). Access charter is part of the Open Data (law Lemaire, 2016). The usage rules are determined by the type CC - BY license. Traceability of usage from citations and DOI.

Data access: full

International dimension

TREEFORCE

Coordinator: Luc Pâques

Coordinating country: France

Partner countries: FI, SE, DE, AT, ES, IT, CH, UK, PL, PT, BE, SI

PNDB

National Biodiversity Data Center

The objective of the RI is to advance the consolidation of knowledge to improve understanding of the state and dynamics of biodiversity. The challenges of research lie in the complexity of interactions between the different levels of organization of living organisms, abiotic factors and pressures. The availability, validation and analysis of data must be facilitated for researchers and decision-makers; their coupling must be promoted in an integrated approach. The missions are:

1. provide access to data, associated services and products derived from analyses;
2. promote scientific animation to identify gaps and encourage the emergence of devices supported by user and producer communities;
3. facilitate the sharing of practices with other research communities, encourage data sharing and reuse, be part of the reflection of the future Earth System infrastructure;
4. promote national and international coherence in accessing and using biodiversity research data, promoting products and services.

Around this data infrastructure, the challenge is to bring together the stakeholder communities in both research and biodiversity management and conservation. The PNDB takes into account the specificities, and needs, of each community and provides integrated and scalable solutions offering operational services to these users. It will be articulated with the SIB (Biodiversity Act 2016) carried by the AFB.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Many "expert reports" based mainly on PNDB data are carried out each year. This is particularly the case for the work of natural space managers, planners/design offices in the framework of impact studies, R and D work... The "raw" data are "public" and are therefore not charged to users. They are made available directly or on request via dedicated platforms: INPN (national) or GBIF (international).

DATA

Estimated volume stored in 2017: 1.2 To

Estimated volume stored in 5 years: 5 To

Data access: restricted

Restrictions: access to sensitive data is restricted in the SINP-INPN. Access to precise data is on request with no redistribution.

International dimension

GEO BON GBIF

Coordinators: GEOBON: Henrique Pereira, GBIF: Donald Hobern

Coordinating country: GBIF Denmark

Partner countries: GEOBON: DE, CA, CN, CO, KP, DK, US, Féroé islands, IS, NO, RU; GBIF: 54 participating countries and 36 organisations

Website: geobon.org, www.gbif.org



Category: RI

Type of infrastructure: Virtual

Infrastructure location: Paris

Other sites:

Aix-en-Provence

French supporting institution: AFB, CNRS, MNHN

Coordinator: Jean-Denis Vigne

Construction: Operation:

2015

2018

Stakeholders in France: BRGM, CIRAD, IRD, IFREMER, INRA (Partner), INERIS, IRSTEA, Université de Montpellier

Contact in France:

jean-denis.vigne@mnhn.fr

ecoscope.fondationbiodiversite.fr/ecoscope-portal
(under construction)

inpn.mnhn.fr

portail.gbif.fr

www.cesab.org

www.naturefrance.fr

Agronomic Resources for Research



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Jouy-en-Josas

Other sites: Paris, Maisons-Alfort, Nouzilly, Orléans, Beaucouze, Rennes, Le Rheu, Marseille, Exmes, Saint-Pierre-d'Amilly, Mignaloux-Beauvoir, Lusignan, Bourran, Cestas, Avignon, Saint-Martin-de-Hinx, Auzeville, Montpellier, Mauguio, Dijon, Sophia-Antipolis, Tours, Thonon-les-Bains, St Pee/Nivelle

French supporting institution: CIRAD, CNRS, IRD, INRA

Coordinator: Michèle Tixier-Boichard

Construction: Operation:

2015

2015

Stakeholders in France: AMU, Montpellier Sup Agro, VetAgro Sup, AgroParisTech, AgroCampus Ouest, Université d'Angers, Université François-Rabelais, Université Rennes I

Contact in France:
michele.tixier-boichard@inra.fr

agrobrc-rare.org

RARE aims at improving the national and European visibility of biological resources maintained by its constitutive Biological Resources Centers (BRC) and at facilitating their use by a large research community, from agriculture research to life sciences and environmental sciences. The microbial pillar of AgroBRC contributes to the construction of the MIRRI infrastructure on the ESFRI roadmap.

The capacity to maintain a large diversity of well documented resources, to collect new ones, to contribute to their characterization, to distribute them and to manage the related data, gives a central role to AgroBRC in numerous research programs aimed at exploring the living world and at making value of biodiversity for agriculture and industry regarding food, environment and health. AgroBRC supports interdisciplinary research and trans-sectorial scientific discussions for various fields of application and fosters technological developments for the conservation and characterization of resources.

The added value of AgroBRC relies on sharing skills, harmonizing practices, triggering projects in comparative biology, and proposing a single entry portal to facilitate access to documented samples. All activities take into account the partnership policies of research institutions as well as the legal frame which varies with the biological nature of resources, for sanitary as well as legal issues. AgroBRC will provide an operational support to BRC managers and users, for the implementation of the Nagoya protocol and French biodiversity law on access and benefit sharing regarding the use of genetic resources.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

AgroBRC partnership concerns cultivated plants and their models, forestry, animal production, agro-food industries, non-food biomass exploitation, biotechnologies and biocontrol. Other partners come from the health and cryobiology sectors. Companies, producer associations or technical institutes use the services of BRCs, contribute to their activities (multiplication, characterization) either directly or within the frame of research and development projects (CASDAR, Regions, ANR, FUI, H2020).

DATA

Estimated volume stored in 2017: 10 To

Estimated volume stored in 5 years: 50 To

Data access: full

Full cost

—
22.4 M€ in 2016

Personnel

—
199.9 FTE in 2016

International dimension

MIRRI, ESFRI Project

Coordinator: Nelson Lima

Coordinating country: Portugal

Partner countries: ES, FR, LV, BE, PL, GR

Website: www.mirri.org

RECOLNAT

Natural History Collections Network

RECOLNAT offers valuing 350 years herbarium, fossils and animals stuffed and conserved in fluid. Public collections in France maintain more than 100 million specimens. This data source has remained neglected for decades. Today it is revisited under cover of the debate on global change. Currently, more than 9 million items are being digitized. The collections represent a scientific heritage, an archive of biodiversity and a major research infrastructure. Access to specimens allowed to found the concepts of current and fossil species. Likewise, data basing is essential for research in taxonomy. The French taxonomic collections are among the first in Europe, but many are underutilized by researchers because inaccessible. For the establishment of common services, RECOLNAT facilitates access and provide better conditions of study. Remote observation images participate in a new way of working through a virtual laboratory. Researchers can then directly consult the specimens they have spotted. RECOLNAT whose collections informs on species, over space and time contributes to environmental expertise, human health and food security. The information is accessible to everyone and everyone can participate in its development. Volunteers form networks of skills and expertise. A citizen science site already offers people to complete the herbarium label from images.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

IR RECOLNAT provides data and services for natural history research, especially systematics, and hence supports any societal need that requires species identification. Besides, it can be directly used for any expertise requiring time and spatial occurrences. It provides access to physical material which is well documented regarding, taxonomy, location and collecting date. RECOLNAT data are available through institutional, national and international databases (such as GBIF).

DATA

Estimated volume stored in 2017: 500 To

Estimated volume stored in 5 years: 1,000 To

Embargo period: 60 months

Data access: restricted

Restrictions: data protected by any kind of regulation (environment, IPR) are restricted to specific evaluated requests or "blurring" and any sort of equivalent procedure.

Full cost

31.9 M€ in 2016

Personnel

166.2 FTE in 2016

International dimension

DiSSCo

Coordinator: Dimitris Koureas

Coordinating country: Netherlands

Partner countries: AT, BE, DE, BU, DK, ES, EE, FI, GR, IT, NO, NL, PT, CZ, UK, SK, SE

Website: diSSCo.eu



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris

French supporting institution: MNHN

Director: Michel Guiraud

Construction: Operation:

2016

2019

Stakeholders in France: IRD, INRA, CNAM, Université Claude Bernard – Lyon 1, UCA, Université de Bourgogne, Université de Montpellier

Contact in France:
mguiraud@mnhn.fr

www.recolnat.org

French seismic and geodetic network/ European Plate Observing System



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: about a hundred of measure points over the national territory

French supporting institution: CNRS

Director: Andrea Walpersdorf

Construction: Operation:

2011

2011

Stakeholders in France: BRGM, CNES, CEA, IRSN, IRD, IFREMER, IFSTTAR, IGN, IPGP, OCA, UCA, UGA, Université de Montpellier, Université de Nantes, Université de Strasbourg, Université de Toulouse 3 – Paul Sabatier, Université Nice – Sophia-Antipolis

Contact in France:

andrea.walpersdorf@univ-grenoble-alpes.fr

www.resif.fr

RESIF/EPOS aims at creating a leading edge research facility for observing and understanding the interior of the Earth. RESIF/EPOS will provide data for studying seismicity and seismic wave propagation and earth structure using seismometers, GNSS antennas and gravimeters, jointly measuring Earth deformation at all time scales, from slow tectonic movements to high frequency seismic shaking. The whole metropolitan France will be densely covered with permanent seismic and geodetic instruments; thus opening a new window to the Earth's interior and to the understanding of the Earth's dynamics from the inner core to the interaction of the solid Earth with the atmosphere and hydrosphere.

RESIF/EPOS will additionally shed new light on natural hazards in France. Major earthquakes are rare in metropolitan France, but their socio-economic impact is potentially such that the mitigation of vulnerability and seismic risk is becoming a major concern. Through joint approaches of seismic imaging and geodesy, RESIF/EPOS will also produce and distribute data that will contribute to our knowledge of the Earth's crust, thereby contributing to an optimal management of France's natural resources. All data produced by RESIF are distributed freely through standard data distribution channels and tools.

RESIF/EPOS is a major French contribution to EPOS (European Plate Observing System) and coordinates EPOS activities in France. EPOS is in its implementation phase (2015-2019), during which EPOS-ERIC will be established.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The socio-economic impact of RESIF-EPOS is important, in particular through the knowledge of the seismicity and the characteristics of seismic wave propagation on the French territory, and the impact of these research subjects on prevention and operational aspects: evaluation of hazard and risk, building norms, relation between damage of buildings and seismicity, elements of reinsurance, induced seismicity by human activity, etc.

DATA

Estimated volume stored in 2017: 75 To

Estimated volume stored in 5 years: 300 To

Data access: full

Full cost

—
6.8 M€ in 2016

Personnel

—
41.5 FTE in 2016

International dimension

EPOS, ESFRI Landmark

Coordinator: Massimo Cocco

Coordinating country: Italy

Partner countries: BE, DE, DK, ES, FI, GR, HU, IE, IS, IT, NO, NL, PL, PT, CZ, RO, UK, SI, SE, CH

Website: www.epos-ip.org

SAFIRE

The French facility for airborne research

SAFIRE operates three research aircrafts (ATR 42, Falcon 20 and Piper Aztec) covering different flight domains allowing one to achieve campaigns of scientific measurements in the following areas: physics and chemistry of the atmosphere, land and ocean surfaces, space research and technology. SAFIRE aims at the following scientific objectives, conducted with external scientific teams:

- acquire data at different altitudes during coordinated observation campaigns to support advances in the understanding of environment processes;
- conduct campaigns of calibration/validation of new onboard instruments for satellite missions, and of instruments concepts prefiguring future space missions.

The 3 airplanes have many specific emplacements for any equipment or instruments. SAFIRE provides its unique expertise to scientific communities for installing different equipment and instruments onboard, and then for preparing and performing measurements flights around the world, according to any need.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

As part of its excellence objectives in aeronautical R et T, SAFIRE works in collaboration with several aeronautical or space industry companies. These are major groups such as Airbus, Dassault Aviation, Thales Alenia Space, Boeing, Honeywell, Thales, ATR but also SMEs such as Atmosphere or AJS. In addition, SAFIRE collaborates with other French SMEs such as CIMEL, IXBlue and MeteoMODEM, for the development and marketing of their products.

DATA

Estimated volume stored in 2017: 5 To

Estimated volume stored in 5 years: 20 To

Data access: restricted

Restrictions: access to data may be limited to project holders for a variable duration (0.5 to 2 years), according to agreements on data policies. The data are normally accessible to everyone.

Full cost

6.3 M€ in 2016

Personnel

25.5 FTE in 2016

International dimension

EUFAR

Coordinator: Philip Brown

Partner countries: BE, DE, FR, PL, CZ, UK, IT, RO

Website: www.eufar.net



Category: RI

Type of infrastructure: Single site

Infrastructure location: Cugnaux

French supporting institution: CNRS, CNES, Météo-France

Director: Aurélien Bourdon

Construction: Operation:

2005

2005

Contact in France:

aurelien.bourdon@safire.fr

www.safire.fr

IR SYSTÈME TERRE

Data and services for the Earth System



Category: Project

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Paris, Toulouse, Montpellier, Brest

French supporting institution: CNRS

Director: Frédéric Huynh

Construction: Operation:

2016

2020

Stakeholders in France: CNES, IRD, IFREMER, IGN, IRSTEA, Météo-France, IPGP, INRA, CIRAD, CEA, ONERA, SHOM, Sorbonne Université, École Polytechnique-X, Univ Lille Nord de France, Univ Grenoble Alpes, Univ Montpellier, Univ fédérale Toulouse Midi Pyrénées, Univ Clermont-Auvergne, Univ Strasbourg, CEREMA, Univ Bordeaux Montaigne

Contact in France:
frederic.huynh@ird.fr

www.theia-land.fr

www.aeris-data.fr

www.odatis-ocean.fr

www.poletterresolide.fr

(IR website in progress)

The integrated knowledge of the Earth system is based on data acquired at different scales of space and time by satellites, ships, planes, balloons, in-situ measurements. This numerical information constitutes a heritage that must be preserved in long-term databases and shared knowledge. Besides facilitating access to high quality data and information products across all compartments of the Earth system, regardless of their nature, the mode of collection and location is a key issue. Observe, understand and predict in an integrated way the history, the functioning and the evolution of the Earth system under the effect of global changes is a fundamental research issue and a necessity for many environmental and socio-economic applications in connection with the implementation of the sustainable development goals. This requires innovative interoperable infrastructures to accelerate the extraction, analysis, dissemination and intelligent use of data, indicators and models from national and international observing systems.

Designed for the scientific community, public policy and socio-economic development actors, these products and services are accessible via portals and dedicated sites. They contribute to space missions, observation networks and support services mechanisms for sustainable development policies. Coordinating, federating and optimizing, within the same RI, all existing institutions, devices and means is one of the important ambitions of the RI System Earth, which also has a European and international vocation in the field.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Relations with economic actors are important. They are organized around clusters in the framework of partnerships with innovative and industrial companies mainly on common access platforms to data, products and tools to develop services adapted to specific needs. For example, the very high spatial resolution satellite data portal (DINAMIS) is used by the scientific community, public actors and service companies in connection with local authorities.

DATA

Estimated volume stored in 2017: 7,000 To

Estimated volume stored in 5 years: 50,000 To

Embargo period: in some cases 12 to 24 months depending on the data type.

Data access: restricted

Restrictions: specific restrictions may exist for periods of exclusivity linked to certain data, protection of sensitive resources, respect for third country rights (ZEE, APA, etc.).

Full cost

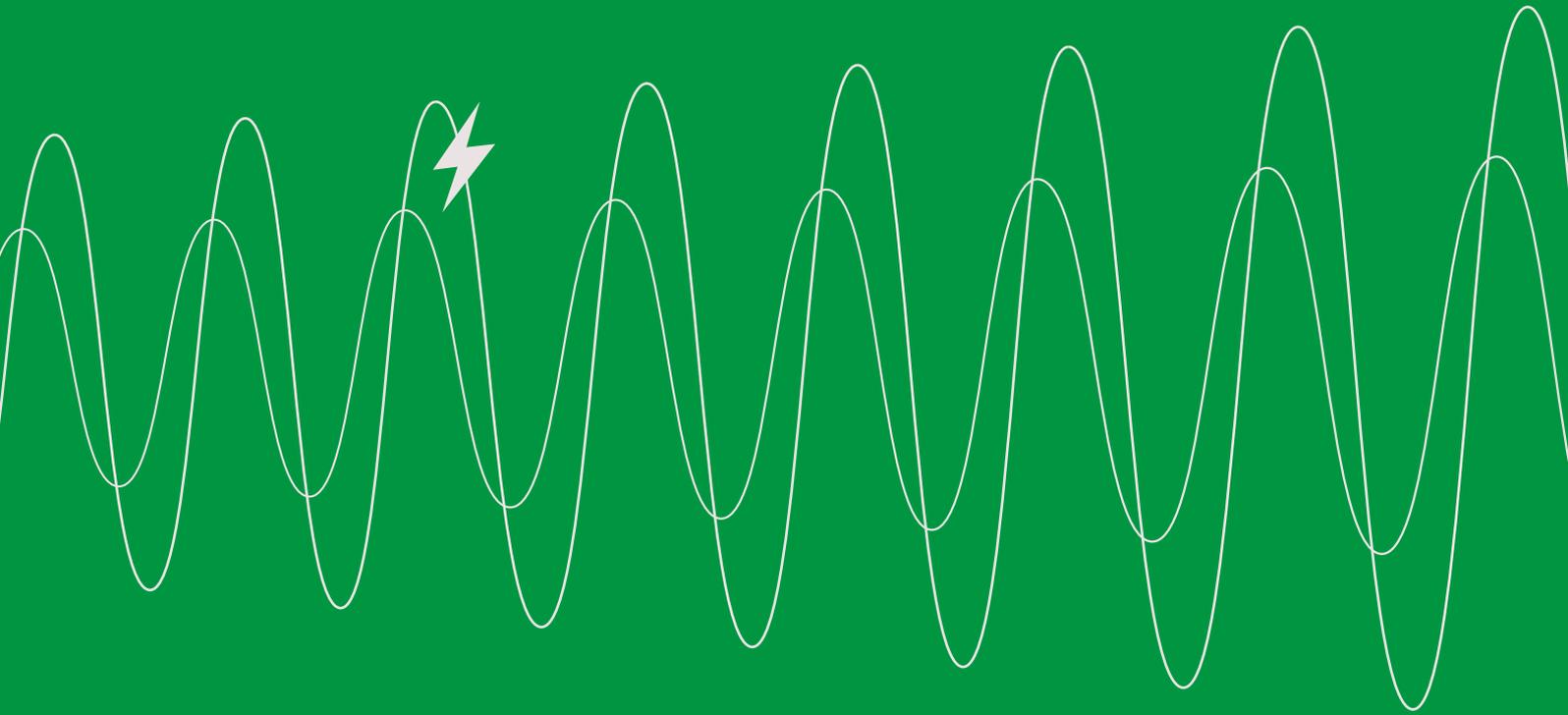
—
33.6 M€ in 2016

Personnel

—
153.2 FTE in 2016



ENERGY



Energy

CONTEXT

To control the global warming, to improve the air quality, to introduce a diversified energy mix are so many challenges to reach a sustainable development. These big challenges structure in the great majority of the cases, guidelines proposed in the institutional plan either through European directives, in particular for REN, or at the national level as Climate Plan. This legislative set has to allow an access to the long-lasting energy with a reduced environmental impact, so on a local scale as in the global one. The energy sector has to adapt itself to the evolution of the request by answering great shifts necessary for the various scales. For example in France, the defined targets by the law have to lead to a reduction of the 40% greenhouse gas emissions in 2030 with regard to 1990. Reduction of fossil resources and diversification of the supplies are the big determiners to answer the big climatic challenges: thus the 21st century will be the one of the energy transition and the control of the energy mix on the horizon on 2050 is an international major challenge leading to very big needs in search and in specific equipments.

THE MAIN PROGRESS AXES AND ASSOCIATED INFRASTRUCTURES

The future energy mix requires to spread quickly alternate solutions: the biomass, the valuation of waste, the solar energy, the wind energy, the marine energies, the geothermal science, while pursuing the development of the new generation nuclear energy and by reducing very significantly the carbon footprint of industries, using CCUS technologies. A very wide diversity of solutions exists but whatever is the shape, they require important investments, important research and development works, with a strong need in dedicated infrastructures. In association with the Alliance ANCRE, a set of Infrastructures was identified to allow the energy transition. 5 big domains are so taken into account:

- the solar energy, in particular in concentration;
- the marine energies;
- the nuclear power;

- the reduction of the carbon footprint of the power production industries;
- the biotechnologies.

The large-scale deployment of variable renewable energies requires the use of new, more efficient and/or more competitive facilities that are not yet available or only at the prototype stage. To reach these ambitious objectives, important research efforts, based on advanced experimental means up to the pilot scale, are therefore necessary.

The axes favored for the next years to reach the required levels of maturity will concern:

1. the renewable energies, in particular:
 - **the solar energy, more specifically the concentrated solar energy**
Fr. Solaris, the French node of the infrastructure Eu Solaris "European SOLAR Research Infrastructure for Concentrating Solar power - registered in the roadmap ESFRI since 2010), offers adapted equipment for the development of this technology. It will be on Odeillo/Thémis's solar installations for the concentrated solar energy (this infrastructure carried by the CNRS);
 - **the marine energies:**
the energies of seas (currents, tides, swell, heat energy) represent a very important but little exploited deposit because very difficult "to domesticate" and to study. Foremost medium-term are the energy marine turbine, the offshore wind energy and the energy of tides. Today still few equipment is available to accompany these developments. **THEOREM** offers a hydrodynamic trial potential. This equipment is organized around one of the École Centrale of Nantes and Ifremer. It is also the French node of the European project of ESFRI Marinerg-i;
 - **the biomass:**
the use of biomass for energy is not new. However, the biotechnologies will allow new approaches for the energy production and for the processing of biomass. The distributed Infrastructure IBISBA-FR, controlled by INRA, which constitutes the French node of IBISBA-EU, contributes to the development of the industrial biotechnology in France for energy;
2. On the nuclear energy:
Nuclear energy will contribute significantly to the French electric mix in a short future - means - long term, with the third generation reactors (EPR) under construction and those of the fourth generation on the horizon 2040-2050. More upstream researches for the development

of the nuclear fusion are in progress and the realization of a technological demonstrator (DEMO after ITER) will ask even for several decades. To offer the experimental equipment to improve the knowledge in the field of the nuclear fusion is of a big importance. **WEST (Tungsten (W) Environment in Steady-state)**, a big infrastructure is which joins in this need. It contributes to new development of the tokamak TORE Supra, (built and operated under the aegis of the Association EURATOM-CEA in the 80s) towards a configuration (with divertor of tungsten) which prefigures that retained for ITER. Concerning the infrastructure ITER itself, although managed in specific frames, it must be mentioned for her importance. Indeed, it has to demonstrate the control of a thermonuclear plasma by a magnetic containment and allow to prepare the demonstration in the reactor DEMO of all the technologies required by a thermonuclear reactor of power. Within the framework of an international cooperation, ITER is under construction in France, on the site of Cadarache with a contribution of Europe;

3. on the drastic reduction of the CO₂ footprint of industries with CO₂ intensive emissions as electricity production units using fossil resources which will accompany the energy and ecological transition. In this case, the capture, the transport, the storage and the valuation of the CO₂ is a complete need. **ECCSEL FR** is a distributed infrastructure totally dedicated to this target, which leans on the means of laboratories and French actors from industry. ECCSEL FR is piloted by the BRGM with IFPEN, ANDRA, INERIS, TOTAL, EDF. ECCSEL FR (European Carbon dioxide Captures and Storage Laboratory) is the French node of ECCSEL-EU, having ERIC's status since June 2017.

RESEARCH INFRASTRUCTURES ENERGY

CATEGORY	NAME	FULL NAME	ESFRI
RI	FR-SOLARIS	Solar Thermal Research Infrastructure for Concentrated Solar Power	EU-SOLARIS (2010)
RI	ECCSEL-FR	European Carbon Dioxide Capture and Storage Laboratory Infrastructure	ECCSEL (2008)
RI	IBISBA-FR ¹	<i>Industrial Biotechnology Innovation and Synthetic Biology Acceleration</i>	
RI	Theorem	Testing facilities for Hydrodynamics and Marine Renewable Energy	
RI	WEST	W(Tungsten) Environment for Steady-state Tokamaks	

¹ RI at the interface with the sector "Earth system and Environmental sciences" as well as with the sector "Biology and Health". RI description can be found in the sector "Biology and Health".

French Research Infrastructure on Concentrating Solar Thermal



Category: RI

Type of infrastructure: Single site

Infrastructure location: Odeillo

French supporting institution: CNRS

Infrastructure coordinator: Alain Dollet

Construction: **Operation:**

1962

1969

Contact in France:

alain.dollet@promes.cnrs.fr

www.promes.cnrs.fr

The FR-Solaris infrastructure brings together the main national R&D resources in the field of concentrated solar thermal. It provides the national and international scientific community with test facilities, solar concentrators and associated instrumentation, required for the development of scientific and technological research in this field. The main objectives of FR-Solaris are: - improvement of technologies for conversion and storage of solar thermal energy; - development of knowledge in the following areas: photophysics/photochemistry (eg photocatalysis), thermochemistry (eg production of synthetic fuels), thermal science, metallurgy (eg surface treatment, sintering), nanomaterials (eg development of nanopowders), ceramic materials (space applications in particular).

5 main sets of equipments are available: - one 1 MWth solar furnace and its dedicated equipment - 11 small/medium size (1-6 kWth) solar furnaces and associated testing devices; - one 50 kWth parabolic concentrator; - one 150 kWth (15 kWel) mini-power plant; - one 5 MWth solar tower.

The main services offered are: - access to small solar furnaces for public research teams; - measurements and tests at high temperature (up to 3,000 °C); - definition and realization of collaborative projects; - assistance with the introduction of instrumentation adapted to concentration systems; - qualification of solar components; - accelerated ageing tests under solar irradiation.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Each year, several contracts in partnership with industrial companies are conducted using FR-Solaris solar facilities. These contracts are either direct research contracts with industry or European contracts (FP7, H2020) involving both public research centres and industrial companies. Through PROMES laboratory, Fr-Solaris is also member of the DERBI competitiveness cluster and partner of the AxLR technology transfer acceleration company.

DATA

Estimated volume stored in 2017: 30 To

Estimated volume stored in 5 years: 300 To

Data access: restricted

Restrictions: total restriction to third parties for confidential projects; partial or total access for the partners of these projects. For other types of data, possible access on request.

Full cost

3.9 M€ in 2016

Personnel

13.9 FTE in 2016

International dimension

EU-Solaris, ESFRI Project

Director: Diego Martinez

Coordinating country: Spain

Partner countries: FR, DE, CY, GR, IT, PT, TR

Website: www.eusolaris.eu

European Carbon Dioxide Capture and Storage Laboratory Infrastructure – French node

CO₂ capture and storage (CCS) is a key technology for mitigating climate change. To accelerate its development and enable its implementation in Europe and worldwide, research and innovation efforts must be intensified in order to reduce the costs of the various technological links and to ensure their efficiency and safety. The ECCSEL infrastructure provides cutting-edge experimental sites and benches for European researchers and engineers to develop and test new tools, processes and methods along the entire value chain: CO₂ capture, transport, geological storage, also paving the way for CO₂ use options. ECCSEL-FR brings together all French research facilities and organizations to ensure the French presence in the European ECCSEL infrastructure:

1. CO₂ capture: - CO₂ capture pilot on coal-fired power station (EDF), Le Havre;
2. CO₂ transport: - SAFETY – Experimental platform for gas transport (INERIS), Mont la Ville, COOTRANS – CO₂ transport loop (TOTAL), Lacq - in project;
3. CO₂ storage: - BIOREP - BIO-Reactor for Deep Environments (BRGM), Orléans, LS-Andra – Meuse/Haute Marne Underground Laboratory (Andra), Bure, CATLAB - Experimental CO₂ injection site and associated analysis laboratory (INERIS), Catenoy - ESCORT - Mobile equipment for on-site detection of the origin of CO₂ trapped in soils (IFPEN), Rueil Malmaison, Gas-Geochem - Laboratory of analysis and interpretation of gas geochemistry (IFPEN), Rueil-Malmaison.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

ECCSEL will build relationships with various private and public actors in research and innovation. In France they are gathered in the Club CO₂, GIS GEODENERGIES, ANCRE and ALLENNVI alliances, AVENIA and AXELERA competitiveness clusters, etc. EDF and TOTAL are two private partners who have integrated the French node of ECCSEL: EDF is providing its CO₂ capture pilot on the Le Havre coal-fired power station, TOTAL is studying the possibility of constructing a CO₂ transport loop at Lacq.

DATA

Estimated volume stored in 2017: 10 To

Estimated volume stored in 5 years: 50 To

Data access: restricted

Restrictions: depending on the funding sources and research contracts, the data are either public or restricted. All data acquired through publicly funded projects will be public.

Full cost

5.9 M€ (estimation)

Personnel

4 FTE

International dimension

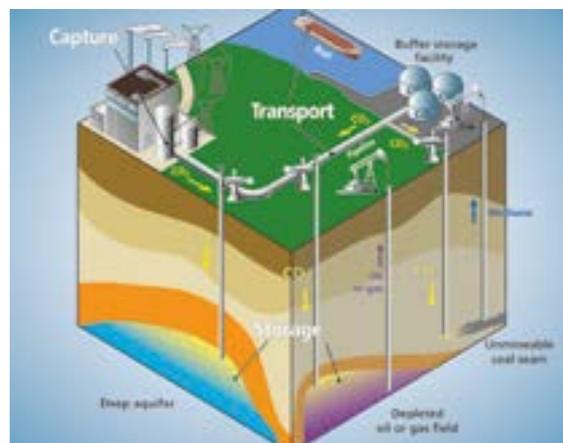
ECCSEL, ESFRI Project

Director: Sverre Quale

Coordinating country: Norway

Partner countries: FR, IT, NL, UK

Website: www.eccsel.org



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Orléans

Other sites: Bure, Catenoy, Lacq, Le Havre, Mont-la-Ville, Rueil-Malmaison

French supporting institution: BRGM

Infrastructure coordinator in France: Isabelle Czernichowski-Lauriol

Construction: Operation:

2017

2017

Stakeholders in France: ANDRA, EDF, IFPEN, INERIS, TOTAL

Contact in France:

i.czernichowski@brgm.fr

www.eccsel.org

Testing facilities for Hydrodynamics and Marine Renewable Energy



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Plouzané

Other sites: Nantes, Le Croisic, Boulogne-sur-mer, Sainte-Anne-du-Portzic

French supporting institution: IFREMER, École centrale de Nantes

Infrastructure coordinator in France: Jean-Marc Daniel, Pierre Ferrant

Construction: Operation:

2015

2016

Contact in France:
jmdaniel@ifremer.fr

www.theorem-infrastructure.org

The infrastructure is based on the networking of the hydrodynamics testing facilities of 2 sites:

- École Centrale of Nantes: - Towing Tank: Built in 1977 and enlarged in 2000, it is the second longest towing tank in France. - Ocean engineering Basin: Operated since 2000 and unrivaled in France for wave testing, the basin size and the capacity of the wave generator. - Shallow Water Wave Basin: Operated since 1982, upgraded in 2014 by adding a false bottom for shallow water testing and implementation of a current generator. - SEMREV - Open Sea Testing Site (Le Croisic): Only operational open sea multi-technologies MRE testing site available in France, developed since 2007, grid-connected and instrumented. Staff and dedicated office in Le Croisic (44);
- Ifremer: - Ocean Engineering Basin (Brest): built in the 70s and equipped with a wave generator. Hydrodynamics testing and testing of devices before deployment at sea. Unique in Europe for its great depth (10 m/20 m) and seawater filling. - Wave and Current Flume (Boulogne-sur-Mer): in 1990, Ifremer acquired a circulation flume, unique facility in France and Europe, dedicated to the study of the behavior of underwater devices. Equipped in 2010 with a wave generator for the assessment of wave-current interactions. - In situ experimental station in Sainte-Anne-du-Portzic.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Theorem promotes research partnerships between academics, technical centers, and industrial developers. The latter can thus proceed through experimental testing, and coupled approach with numerical modelling, to the de-risking of their concepts and designs, before moving on to the deployment stage of pilot systems. In addition to the Marine Renewable Energy (MRE) development, the testing approach also responds to the needs of the offshore oil et gas industry and all the needs of the naval industry.

DATA

Estimated volume stored in 2017: 10 To

Estimated volume stored in 5 years: 100 To

Embargo period: 24 months

Data access: restricted

Restrictions: restriction according to signed contracts and Non Disclosure Agreements

Full cost

—
5.4 M€ in 2016

Personnel

—
31.7 FTET in 2016

International dimension

Marinerg-i

Coordinator: Jimmy Murphy

Coordinating country: Ireland

Partner countries: DE, BE, DK, ES, IT, NO, NL, PT, UK, SE

Website: www.marinerg-i.eu

WEST



W(Tungsten) Environment for Steady-state Tokamaks

The WEST objective is the validation of the design and manufacturing of ITER divertor. To do this, a large number of actions is required, involving:

- a detailed design checking the validity of ITER assumptions;
- understanding and mastery of plasma-wall interaction in metallic environment, erosion/redeposition and retention of plasma fuel; behavior of materials under extreme conditions; measurement and interpretation of surface temperatures in reflective 3D environments;
- industrialization of components (quality, zero-defect production, cost control...);
- operational procedures of the divertor in ITER; measurement methodologies and real-time control;
- component behavior in the period of operation: alterations, repair/refurbishment protocols;
- a partnership investment of 24.8 M€ to change the Tore Supra plasma chamber to add a cooled tungsten divertor, plasmas production, and characterization;
- pay-per-view investments of the partners allow enriching the diagnostics set, following a model of procuring "turnkey", including scientific staff and experimental proposals;
- the IRFM simulation and modeling platform for the preparation, conduct and interpretation of experiments;
- a docking platform for staff, and a specific organization of IRFM promoting their integration.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The WEST RI generates its own industrial activity, linked to both its development (supply and/or service contracts) and its operation (services through framework contracts mainly). After a first step rebuilding its internal components (phase I of the project), generating a hundred contracts with industries and service providers, WEST entered early 2018 in its first phase of scientific exploitation and the phase II of its construction.

DATA

Estimated volume stored in 2017: 5 To

Estimated volume stored in 5 years: 50 To

Data access: full

Full cost

18.7 M€ in 2017
(estimation)

Personnel

100 FTE in 2017
(estimation)

International dimension

WEST

Coordinator: Maria FAURY

Coordinating country: France

Partner countries: DE, CN, KP, USA, IN, JP, LB, PL, CZ

Website: west.cea.fr



Category: RI

Type of infrastructure: Single site

Infrastructure location: Saint-Paul-lez-Durance

French supporting institution: CEA

Director: Alain Becoulet

Construction: **Operation:**

2012

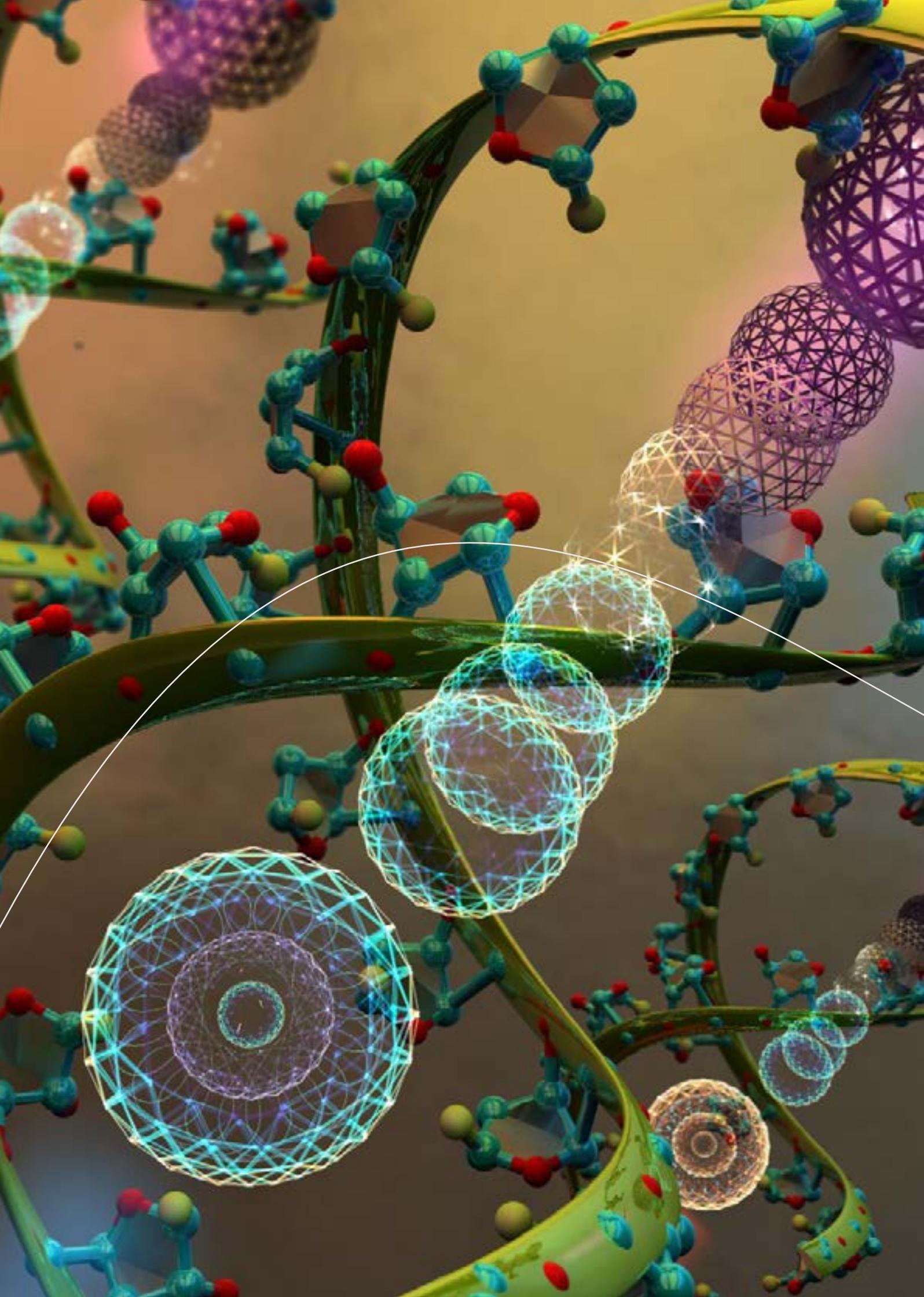
2018

Stakeholders in France: ANDRA, IFPEN, INERIS, EDF, TOTAL E and TEPRD

Contact in France:

alain.becoulet@cea.fr

<http://west.cea.fr/en/index.php>



BIOLOGY AND HEALTH



Biology and Health

The field of life sciences has undergone major and very fast changes over the last two decades. The change in scale induced by the technology boom and the integration of data from very diverse origins, in particular genomic sequencing which has initiated the era of high throughput biology, high-resolution imaging and biophysics, have revolutionised the approaches for exploring living organisms

The technologies needed for exploring and characterizing life, combined with expensive equipment, managed by highly qualified personnel, have required setting up collective research infrastructures that are open to all of the scientific communities.

The infrastructures for life sciences research have been added for the first time to the national roadmap in 2008. This manifests the success of a long structuring policy conducted jointly by the life sciences community, the national research institutions concerned and the Ministry of Higher Education and Research since the 1990s.

In 2010 and 2011, in the framework of the Biology and Health program of the Investments for the Future Program (PIA), two successive calls for tender for national infrastructures in Biology and Health were launched, underlining the importance of technological infrastructures in maintaining research excellence in the field of life sciences. The results of this program, the scientific and technological excellence of which was highlighted in a recent international evaluation, have amply demonstrated the essential role played by the organizational and structuring policies of the research institutions and the ministry. In addition, GIS-IBISA has played a key role in promoting the effective structuring of teams and sites.

As a consequence, national research infrastructures have emerged with the aim to promote access to resources, for example to support the development of omics and imaging or the development of translational research. Some of these national infrastructures are the French components of ESFRI's European infrastructures (European Strategic Forum for Research Infrastructures) and thus contribute to our international scientific visibility and the construction of the European Research Area.

The Biology and Health research infrastructures are open to academic and industrial scientific communities. They have a transparent governance and a centralized access

procedure. They bear certain specificities, which distinguish them from the single-site VLRI of this roadmap, such as being often distributed over several geographical sites. They nevertheless form units that can sometimes exceed 100 FTEs. Their budget is not secured through the Major Research Infrastructures action in the Budget bill and the institutions are the main direct financers of these infrastructures. User access often relies on financial contributions from the resources of research groups. This could be felt as weakening and complicating the economic model for these infrastructures but forster openness and outreach, and brings greater flexibility and responsiveness. For each Biology and Health infrastructure, a higher education or research institution has been identified as the national coordinator/facilitator. Securing their future remains a challenge that must be addressed for the support of the scientific communities, which benefit from the competitive high-tech services provided.

Some of the infrastructures listed under the *Biology and Health, Earth System and Environmental Sciences, or Matter Sciences and Engineering* headings cover areas of joint interest.

France is a member of **EMBL**, an international organization, which, with six research sites, is one of the leading centers of excellence in basic biology research worldwide. The other Biology and Health infrastructures presented here are organised into 4 thematic groups:

- I. the **functional investigation RIs** group state-of-the-art technologies for studying the various components of living organisms. One of the challenges addressed with these infrastructures is, in a systems biology approach, to decrypt, on the scale of a cell, a tissue, an organ or a living organism, the dynamic and coordinated operation of a set of molecular actors. On the one hand, the integration of the various experimental and computational technologies allows for multi-resolution synergistic approaches in space and time. On the other hand, the multi-scale analysis of heterogeneous, structural and also functional data has for purpose to integrate the atomic and cellular, and even tissue aspects;
- II. the **RIs providing model organisms and biological resources** make available the biological models and samples required for studying living organisms. Analytical methods at increasing resolution and new

engineering technologies of the genome (CRISPR technologies in particular) require standardised analytical approaches of phenotypes of target organisms and to have annotated biological resources made available for which the quality and traceability are guaranteed. Some of these infrastructures have the assigned role of providing the laboratories with the required models. Others provide pluripotent stem cells of clinical grade and collections of human and microbial biological resources the community.

The increasingly finer characterisation of biological resources now makes it possible to propose inverted approaches to build according to qualified methods, entities having sought biological activities, plasmids, enzymes, etc. This industrial and/or synthetic biotechnology, which complements systems biology, is a major driving force for innovation in bio-economy, for health and nutrition as well as for fine chemicals synthesis;

III. the **RIs in preclinical and clinical investigation** concern research that can be transferred or is transferred to Man. They include the structures that make it possible to accelerate the application of medical innovations to the people more likely prone to benefit from them. They provide support to the research conducted on preclinical model organisms or in human volunteers, either healthy or carrying specific diseases or pathogens. This research is associated with all of the infrastructures making it possible to access the development of new therapeutic approaches in conditions that can be used in man (GMP) or that guarantee his safety (biological risk);

IV. the **RIs in bioinformatics, cohorts and databases**. The data produced in biology and in medicine are increasing exponentially and the IRs of this thematic

subset are essentially transverse. The French Institute of Bioinformatics has the ambition to coordinate their use in close interaction with research groups. Constances, a vast general population cohort, participates in supplying data on health for conducting projects in various fields (ageing and chronic diseases, social and professional determinants of health...). It provides health agencies and authorities data for monitoring health indicators and establish of the main determinants of health at the general population level. The CAD (Central Analyser of Data) still under construction is at the heart of the France Genomic Medicine 2025 plan and will provide a bridge between care and research.

As the landscape of Biology and Health infrastructures is constantly changing, the improvement of existing infrastructures and the rapid deployment of new technologies are an absolute priority. The 2018 roadmap includes several new infrastructures or projects (Neurospin, ChemBio-France, CAD...). In addition, there are clearly **emerging infrastructures** in several technological fields (cohorts, health data for research, consumer/food/health relationships, exposome, characterization and valorization of metagenomes...), which should be included in a future revision of the road map. Some of them have received support from the PIA in the Cohortes, Pre-industrial Demonstrators or Equipex programs and the creation of a health data infrastructure for research stems from the law of modernization of our health system.

Landscape analysis taking into account the cross-functionality/complementarity of infrastructures, support of new technological developments, encouragement of convergence and cross disciplinarity initiatives, are key for maintaining infrastructures at their highest level for fully competitive research and innovation.

CATEGORY	NAME	FULL NAME	ESFRI
INTERNATIONAL ORGANISATION			
IO	EMBL	European Molecular Biology Laboratory	
FUNCTIONAL EXPLORATION			
RI	ChemBioFrance	Bioactive molecules discovery platform to explore and cure living organisms	
RI	FBI	France-BioImaging	Euro-Bioimaging (2008)
RI	FLI	France Life Imaging	
RI	France Génomique	National Genomics and Associated Bioinformatics Infrastructure	
RI	FRISBI	French Infrastructure for Integrated Structural Biology	INSTRUCT (2006)
RI	MetaboHub	Development of a distributed coordinated French infrastructure for metabolomics dedicated to innovation, training and technology transfer	
RI	NEUROSPIN	France's research center for innovation in brain imaging technologies	
RI	PROFI	Proteomics French Infrastructure	
MODEL ORGANISMS AND BIOLOGICAL RESOURCES			
IR	CELPEDIA	National Infrastructure for the creation, the functional exploration, the distribution and the archiving of model organisms	INFRAFONTIER (2006)
RI	<i>EMBRC France¹</i>	<i>National Centre for Marine Biological Resources</i>	<i>EMBRC (2008)</i>
RI	<i>EMPHASIS France²</i>	<i>European Infrastructure for multi-scale Plant Phenomics and Simulation for food security in a changing climate (France)</i>	<i>EMPHASIS (2016)</i>
RI	<i>IBISBA-FR³</i>	<i>Industrial Biotechnology Innovation and Synthetic Biology Acceleration</i>	
RI	INGESTEM	Pluripotent Stem Cell and Tissue Engineering	

1 RI at the interface with the sector "Earth System and Environmental Sciences".

2 RI at the interface with the sector "Earth System and Environmental Sciences". RI description can be found in the sector "Earth System and Environmental Sciences".

3 RI at the interface with the sector "Earth System and Environmental Sciences" as well as with the sector "Energy".

CATEGORY	NAME	FULL NAME	ESFRI
PRECLINICAL AND CLINICAL INVESTIGATION			
RI	ECELLFRANCE	French infrastructure for stem cell based therapy	
RI	F-CRIN	French Clinical Research Infrastructure Network	ECRIN (2006)
RI	HIDDEN	Jean Mérieux - Inserm BSL4 laboratory	ERINHA (2008)
RI	EMERG'IN	National research infrastructure for the control of animal and zoonotic emerging infectious diseases through in vivo investigation	
RI	IDMIT	Infectious Disease Models and Innovative Therapies	
RI	NEURATRIS	Translational Research Infrastructure for Innovative Therapies in Neuroscience	EATRIS (2006)
RI	PGT	Preindustrial Gene Therapy consortium	
BIOINFORMATICS, COHORTS AND DATABASES			
RI	CONSTANCES	Population-based epidemiological cohort	
RI	IFB	French Institute of Bioinformatics	ELIXIR (2006)
Project	CAD	Central Analyser of Data	

European Molecular Biology Laboratory



Category: IO

Type of infrastructure: Distributed

Infrastructure location: Heidelberg, Germany

Other sites: Grenoble, Hambourg, Barcelona, Monterotondo, Hinxton

French supporting institution: MESRI

Infrastructure representatives in France:

Anne Paoletti, Elena Hoffert

Construction: Operation:

1974

1974

Contact in France:

anne.paoletti@recherche.gouv.fr

elena.hoffert@recherche.gouv.fr

www.embl.fr

With its six research sites (Heidelberg, Hamburg, Grenoble, Monterotondo, Hinxton, Barcelona), EMBL is one of the major centers of excellence in basic research in biology in the world. Each center has a specific area of research: cell biology and imaging, structural biology, development of mouse models, bioinformatics and systems biology.

The strategic priority of EMBL for the 2017-2021 period is the digital biology. One hundred young scientists selected on their excellent track record are hired as group leaders for periods of 5 to 9 years. They are attracted by the EMBL advanced technologies, for the very stimulating international environment, and for the opportunities to develop scientific collaborations and to be engaged into international networks.

EMBL offers an international doctorate program in Life Sciences (250 students from over 40 countries) and a post-doctoral program. EMBL organizes many renowned courses and conferences (EMBL courses and conferences, EMBL-EBI workshops). EMBL also offers bioinformatics services, in particular databases and bioinformatic analysis softwares, freely available to all researchers, in all areas of expertise of the laboratory. EMBL finally develops core facilities accessible to both internal and external researchers from Member States, in structural biology, imaging, and "omics" technologies.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Valorization and knowledge transfer to industry are among the concerns of EMBL. EMBLEM (EMBL Enterprise Management Technology Transfer), with a GmbH status is the exclusive partner of EMBL for technology transfer. It manages a portfolio of over 250 patents and copyrights (enabling technologies, molecular tools & techniques, instruments & devices as well as computer programs & databases).

French contribution

—
17.6 M€ in 2016

Personnel

—
**1,563 FTE in 2016
(for the IO)**

International dimension

EMBL

Director General: Iain Mattaj

Partner countries: AT, DK, FR, DE, IS, IT, NL, SE, CH, UK, FI, GR, NO, ES, BE, PT, IE, IS, HR, LU, CZ, MT, HU, SK

Website: www.embl.de

National Infrastructure for the creation, the functional exploration, the distribution and the archiving of model organisms

CELPEDIA is a reference infrastructure for animal research. With 15 centres distributed on the territory, experts in the study of model animals, it is essential for basic and biomedical research. CELPHEDIA offers the optimal conditions for the creation, the breeding, the phenotyping, the attribution and the archiving of animal models and the formation of the scientific community from academy and industry. Thus CELPHEDIA is a major player:

- to conduct animal research while ensuring well-being, respect for the 3Rs principles and ethics;
- to advise the use of the most appropriate animal model (non-mammalian vertebrates, rodents (mouse, rat...) and non-human primates);
- to develop innovative, standardized and massively parallel technological approaches to accelerate the fundamental understanding of genes and pathogenic variations involved in animal and human diseases; and to promote therapeutic, pharmaceutical and biomedical innovation;
- to improve and lead harmonization of procedures and protocols, guaranteeing regulatory compliance, efficiency and reliability;
- to support reproducibility through standardized explorations and triangulation methods in order to translate robust results from one model organism to another;
- to facilitate national and international exchanges and access to models of interest;
- to contribute to the international effort of functional annotation of the genome and understanding of human diseases (IMPC).



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Illkirch

Other sites: Rennes, Gif-sur-Yvette, Paris, Clermont-Ferrand, Toulouse, Lyon, Strasbourg, Marseille, Illkirch, Orléans, Nantes, Niederhausbergen, Rousset-sur-Arc

French supporting institution: CNRS

Director: Yann Herault

Construction: **Operation:**

2008

2008

Stakeholders in France: INRA, INSERM, AMU, Université de Nantes, UCA, UDL, Université de Rennes 1, Université de Strasbourg, Université Paris-Saclay, Université Paris-Sud

Contact in France:

herault@igbmc.fr

www.celpedia.eu

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Major sectors of biomedical, pharmaceutical and therapeutics innovation are concerned (from the validation of candidate genes as therapeutic targets to the improvement of drug candidates – main and side effects).

DATA

Estimated volume stored in 2017: 100 To

Estimated volume stored in 5 years: 1,000 To

Embargo period: 24 months

Data access: full

Full cost

44.8 M€ in 2016

Personnel

388.4 FTE in 2016

International dimension

INFRAFRONTIER, ESFRI Landmark, INTERNATIONAL MOUSE PHENOTYPING CONSORTIUM (IMPC)

Coordinators: Martin Hrabe de Angelis (INFRAFRONTIER), Steve Brown (IMPC)

Partner countries: DE, AU, BE, CA, CN, CR, DE, ES, USA, FI, FR, GR, IL, IT, JP, NL, PT, CZ, UK

Website: www.mousephenotype.org

CHEMBIOFRANCE

Bioactive molecules discovery platform to explore and cure living organisms



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Illkirch

Other sites: Toulouse, Paris, Lille, Marseille, Roscoff, Montpellier, Grenoble, Poitiers, Saclay, Orléans

French supporting institution: CNRS

Director: Jean-Luc Galzi

Construction: **Operation:**

2017

2018

Stakeholders in France: CEA, Institut Curie, INRA, INSERM, Institut Pasteur, AMU, Université de Nantes, ENS Chimie Montpellier, ENS Chimie de Paris, Université de Bordeaux, MNHN, Normandie Université, SIGMA, Université Claude Bernard Lyon, Université de Caen, Université de Champagne, UGA, UHA, Université de Lorraine, Université de Montpellier, UPJV, Université de Poitiers, Université de Rouen, Université de Strasbourg, Université Paul Sabatier, Université de Versailles, Université d'Orléans, Université du Maine, Université Grenoble Alpes, Université Lille, Université Lille Nord de France, Université Nice – Sophia-Antipolis, Université Paris Diderot, UPEC, Université Paris-Sud, UPMC, Université Rennes 2, Université de Poitiers, Université de Tours, Université de Brest

Contact in France:

galzi@unistra.fr

www.chembiofrance.fr

Modern technologies for the discovery of bioactive molecules combined with imaging, functional genomics and structural biology constitute a unique framework for understanding life, treating rare or emerging orphan diseases, targeting drug resistance and to address the issue of quality of life throughout whole life.

ChemBioFrance is designed to promote and stimulate exchanges at the interface between chemistry, biology and computer sciences, to develop new strategies for the discovery and development of bioactive molecules, and to serving public and private researchers.

The ambition is to create new discovery tools, to adopt new research practices and to integrate the constraints of development as early as at the conception of projects. To achieve this ChemBioFrance interconnects the national chemical library with the screening platforms, ADME and computing platforms and builds a common culture and synergy of multidisciplinary teams guided by the projects.

ChemBioFrance also creates a collection of standardized (quality control and standardized protocols) and validated targets (accepted model for a given human pathology, an infection, a parasite...), that are distributed according to the model of the national chemical library. ChemBioFrance thus offers scientific and technical solutions to optimize development (TRL 2-6) and increase the success rate in the precommercial and commercial phases (TRL 7-9) of new molecules.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Indicators for the period 2010-2016:

- production: 1,500 publications, > 70 identified molecular probes, collection of 60,000 academic molecules, 15,000 natural extracts, >300 targets, catalog of 300 assays;
- training: 500 doctoral theses supported, more 100 professional Master with tenure position; > 1000 trained public and private agents;
- tech transfer: 84 patents including 35 licensed;
- scientific consultancy/scientific support > 30 companies; creation of 10 strat-ups; services for 7 SATT.

DATA

Estimated volume stored in 2017: 200 To

Estimated volume stored in 5 years: 3-400 To

Embargo period: 36 months

Data access: full

CONSTANCES

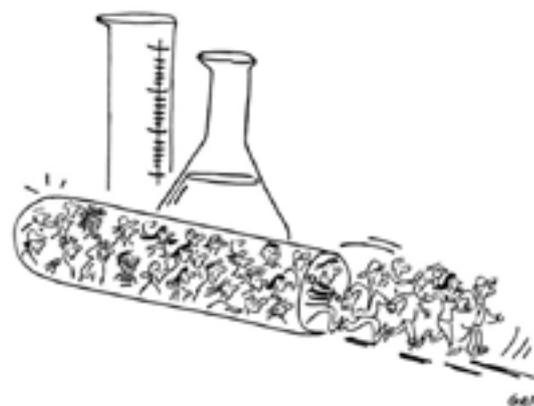


Population-based epidemiological cohort

Constances is an epidemiological prospective cohort made of a representative sample of 200,000 people aged 18-69 at inception. The inclusion takes place in health examinations centers in 21 metropolitan departments, it comprises a health examination, the creation of a biobank and questionnaires (health, lifestyle, socio-occupational factors). Follow-up is active (annual self-administered questionnaire, health examination every 4-5 years) and annual linkage with the administrative databases of the SNDS and of CNAV. The main data concern health, care seeking, biological and physiological parameters, a biobank, demographic and occupational factors). The constitution of the full cohort is planned for early 2019; currently (March 2018) more than 170,000 participants are already included.

Constances is a largely immaterial infrastructure whose mission is essentially to prospectively collect individual participant data from multiple sources. Through calls for proposals, the cohort database is open to the French and international research community; currently, over 70 projects have been approved by the International Scientific Council of Constances.

Constances is the largest French cohort, and participates in several French and European consortia.



RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Constances has contracts with three major drug firms. Regarding the socioeconomic impact, the IR is used by public health authorities and health agencies in order to help defining public policies through the production of statistics for the health of the French population: CESE, Ministry of Health, Ministry of Labor, Mission interministérielle de lutte contre les drogues et les conduites addictives, Conseil national de l'information statistique.

DATA

Estimated volume stored in 2017: 2 To

Estimated volume stored in 5 years: 10 To

Data access: restricted

Restrictions: evaluation of applications by the Scientific Committee and provision of the needed data. Regulatory restrictions: respect of personal data privacy rules.

Full cost

—
19.4 M€ in 2016

Personnel

—
32.5 FTE in 2016

Category: RI

Type of infrastructure: Virtual

Infrastructure location: Villejuif

French supporting institution: Université de Versailles Saint-Quentin-en-Yvelines

Director: Marie Zins

Construction: Operation:

2012

2013

Stakeholders in France: Université Paris Descartes, Inserm

Contact in France:
marie.zins@inserm.fr

www.constances.fr

French infrastructure for stem cell based therapy



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Université de Montpellier, IRMB

Other sites: Clamart, Toulouse, Saint-Ismier, Créteil, Besançon Cedex, Rennes, La Tronche Cedex

French supporting institution: Université de Montpellier

Director: Christian Jorgensen

Construction: Operation:

2012

2012

Stakeholders in France: INSERM, Université de Toulouse 3 – Paul Sabatier, UGA, CNRS, Université de Montpellier, EFS, CTSA

Contact in France:
christian.jorgensen@inserm.fr

www.ecellfrance.com/fr

ECELLFRANCE's mission is to develop cell-based therapies using mesenchymal stem cells (MSCs). These therapies aim at regenerating damaged tissues in many diseases associated with aging and in chronic inflammatory diseases currently with no cure.

ECELLFRANCE is an integrated network of key players in regenerative medicine with a strong positioning in translational research to the clinic. It is equipped with MSC production centers and with clinical immuno-monitoring platforms for patients treated with MSCs. The organization includes cell therapy research teams, clinical and translational research centers, and Advanced Therapy Medicinal Products (ATMP) production centers.

More specifically, ECELLFRANCE's mission is to optimize and harmonize the steps for the development of "stem cells medicinal products" and regenerative medicine in France, and to assist academics and industrials with the implementation of their cell therapy clinical programs: project validation, preclinical studies, regulatory support, MSC production for clinical use, implementation of clinical phase I, II and III trials, patient immuno-monitoring.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

ECELLFrance offers a technological, regulatory and secure framework in line with public health policies. Its impact is important in terms of visibility as shown by its success in national and European programs grants, and in terms of resulting societal and clinical impact. Furthermore, industrial contracts stimulate technical developments and contribute to the profitability and the valorization of the infrastructure.

DATA

Estimated volume stored in 2017: 10 To

Estimated volume stored in 5 years: 50 To

Data access: full

Full cost

5.1 M€ in 2016

Personnel

28.3 FTE in 2016

International dimension

EUROCELL

Coordinator: Christian Jorgensen

Coordinating country: France

Partner countries: NL, IT, DE, DK, CH, ES

EMBRC-FRANCE



National Centre for Marine Biological Resources

EMBRC-France incorporates the services and expertise of the three marine stations belonging to Sorbonne University and the Centre National de la Recherche Scientifique: Banyuls-sur-Mer, Roscoff, and Villefranche-sur-Mer. The infrastructure offers access to marine biological resources via a single access point for academic research (biology, ecology, and oceanography) and for companies in the blue bioeconomy field. EMBRC-France's three sites provide access to their local ecosystems (research vessels and scientific divers), aquaria and wet-lab space with sea-water circulation systems, analytical platforms, as well as on-site accommodation. The principal vocation of the infrastructure is to supply microbial, animal, and plant research models, from all major evolutionary lineages, particularly those not present in terrestrial ecosystems. Genetic resources for certain model organisms, prokaryotes and eukaryotes, are also offered and continue to be developed. EMBRC is thus built around the following services:

- access to marine biological models, from all major evolutionary lineages;
- ex situ experimental platforms for culturing and breeding marine organisms;
- genetic resources for some model organisms, prokaryote and eukaryote;
- genotyping and phenotyping platforms ("omics", imaging, bio-informatics);
- digital resources on marine organisms and ecosystems.

EMBRC-France is at the interface of "biology and health" and "earth systems and environment", and positioned as an essential research tool in marine biology and ecology, as well as supporting innovation and technology transfer.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

EMBRC works to support the development of the blue bioeconomy, and engage with the various economic actors through the technological platforms, our SME incubators, and science park. We actively pursue a strategy of regional engagement and anchorage through our Committee of Regions, and seek to replicate these efforts at the European level. EMBRC is working towards an alignment of research infrastructure policy lines in FP9, Structural Funds, and Investment Funds, across European maritime regions.

DATA

Estimated volume stored in 2017: 2,000 To
 Estimated volume stored in 5 years: 5,000 To
 Data access: full

Full cost

6.0 M€ in 2016

Personnel

46.8 FTE in 2016

International dimension

EMBRC, ESFRI Landmark

Executive director: Ilaria Nardello

Coordinating country: France

Partner countries: BE, ES, GR, IS, IT, NO, PT, UK

Website: www.embrc.eu



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Roscoff, Banyuls-sur-Mer, Villefranche-sur-Mer

French supporting institution: Sorbonne Université

Director: Bernard Kloareg

Construction:

2011

Stakeholders in France: CNRS

Contact in France:

kloareg@sb-roscoff.fr

nicolas.pade@sorbonne-universite.fr

www.embrc-france.fr

National research infrastructure for the control of animal and zoonotic emerging infectious diseases through in vivo investigation



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Nouzilly

Other sites: Montpellier, Ploufragan, Jouy-en-Josas

French supporting institution: INRA

Director: Fabrice Laurent, Frédéric Lantier

Construction: Operation:

2018

2018

Stakeholders in France: ANSES, CIRAD

Contact in France:

fabrice.laurent@inra.fr
frederic.lantier@inra.fr

www.emergin.fr
(under construction)

EMERG'IN is a distributed research infrastructure for the control of animal and zoonotic emerging infectious diseases through in vivo investigation on a very large panel of animals (model species, farm animals, wildlife and arthropod vectors). The infrastructure is constituted by a set of 4 complementary experimental platforms belonging to INRA, to ANSES and to CIRAD. The ambition of EMERG'IN is to provide France with a national coordination tool to increase basic knowledge and propose diagnostic and control solutions for emerging infectious diseases (vector-borne or not), capable of threatening public health or whole areas of animal husbandry. With the support of the Carnot Institutes, EMERG'IN develops public-private partnerships (large companies, SMEs, start-ups) to accelerate the marketing of control or prevention means by private actors of the fields of medicine and veterinary diagnosis. EMERG'IN will organize action plans to coordinate infrastructure entities to respond to requests for animal testing, if necessary in emergency, in case of an emerging disease originating from animals. It helps disseminate know-how on infectious disease experimentation in confined areas and will develop, in partnership with various public and private actors, new alternative methods and innovative devices to limit the number of animals in experimentation.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

EMERG'IN maintains close and regular contacts with all public (universities, research organizations) and private stakeholders of animal health through provision of services and research contracts (national (ANR), European (H2020) or private). The socio-economic impact of EMERG'IN concerns public health, the animal production sectors, the food production chain, the policies and the consumers/citizens

DATA

Estimated volume stored in 2017: 50 To

Estimated volume stored in 5 years: 100 To

Embargo period: depending of the agreement with the user

Data access: restricted

Restrictions: data generated are the property of public or private partners and restrictions may apply for their dissemination. The implementation of a policy on data management will facilitate their diffusion.

International dimension

VetBioNet

Coordinator: Frédéric Lantier

Coordinating country: France

Partner countries: AU, CA, CH, DE, DK, ES, IR, IT, KE, NL, PL, UK, US

Website: www.vetbionet.eu



HIDDEN

Jean Mérieux - Inserm BSL4 laboratory

Because of their dangerousness, Risk group 4 pathogens must be handled in biosafety level 4 (BSL4) laboratories with main activities concerning diagnosis, management of collections and research. Amongst the 7 operational European BSL4 laboratories, the Jean Mérieux - Inserm BSL4 laboratory is the only French civil laboratory presenting this level of biosafety containment. It proposes the largest BSL4 capacities dedicated to the human health, in particular concerning animal experimentation. It is the only one in Europe having capacities allowing the implementation of protocols using animal models ranging from rodents to non-human primates. The Jean Mérieux - Inserm BSL4 laboratory which is under the authority of Inserm since 2004 is organized as a large infrastructure open to the entire national and international scientific community. This organisation is unique in the world for this type of infrastructure. Due to the increasing number of research programs submitted and the evolution of standards and regulation, the HIDDEN project proposes an extension of the existing BSL4 laboratories that will bring a major provision for animal experimentation capacities, diagnosis and microorganism collection management, preparedness for potential bacteria experimentation and will ensure permanent BSL4 capacity availability.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The Jean Mérieux - Inserm BSL4 laboratory is open to the whole scientific community. Its involvement in private/public partnership concerns private companies as well as governmental initiatives such as Bioaster and Lyon-Biopole. It allows the implementation of preclinical test needed for the development of diagnostic, prophylactic and therapeutic tools. Such partnership has been strengthening during the past years with the implementation of large innovative programs related to the Ebola outbreak.

DATA

Estimated volume stored in 2017: 10 To

Estimated volume stored in 5 years: 50 To

Data access: restricted

Restrictions: The data produced in the frame of the infrastructure activities are considered as sensitives. Access to these data stored on a secured network will then be restricted.

Full cost

5.0 M€ in 2016

Personnel

28.2 FTE in 2016

International dimension

ERINHA, ESFRI Project

Director: Hervé RAOUL

Coordinating country: France

Partner countries: PT, SE, HU

Website: www.erinha.eu



Category: RI

Type of infrastructure: Single site

Infrastructure location: Lyon

French supporting institution: INSERM

Director: Hervé Raoul

Construction: Operation:

1999

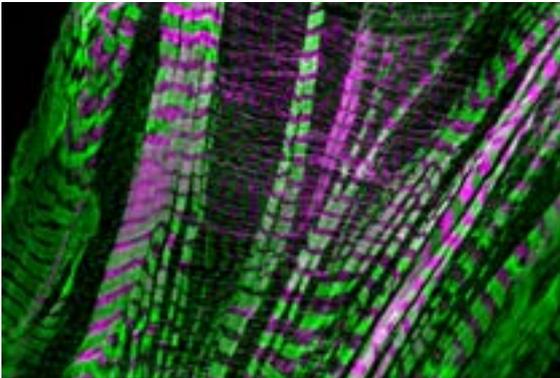
2001

Contact in France:

herve.raoul@inserm.fr

www.p4-jean-merieux.inserm.fr

France BioImaging, a distributed but coordinated national infrastructure in bioimaging



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris, Institut Curie

Other sites: Paris, Marseille, Bordeaux, Montpellier, Gif-sur-Yvette, Rennes

French supporting institution: CNRS

Director: Jean Salamero

Construction: Operation:

2011

2012

Stakeholders in France: Institut Curie, INSERM, INRIA, Institut Pasteur, AMU, ENS ULM, École polytechnique – X, Université de Bordeaux, Université de Montpellier, Université Paris Descartes, Université Paris Diderot, Université Paris-Sud, Sorbonne Université

Contact in France:
contact@france-bioimaging.fr

france-bioimaging.org

To fulfill its main mission of enabling access to the latest innovations in Life Science Imaging, FBI:

- explores new strategies in BioImaging and encourages their applications. It represents a large scale research tool in many areas, from plant or stem cells biology, to preclinical and translational studies on cancer or neurodegenerative diseases;
- aims at fostering technological transfer of bio-imaging innovations from its R et D Expert Teams onto its Core Facilities, thus speeding up access to advanced techniques and methods in microscopy and of image analysis, while ensuring quality control and sustainability both of operating systems and of produced data;
- participates in the socio-economic development through industrial partnerships, in particular for drug or cosmetics screening and development);
- supports activities promoting BioImaging for life Sciences, organizes or participates in national and international education and training programs (FBI-AT; EMBO courses and workshops, ELMI meetings, MiFoBio CNRS school...)
- is involved in diverse H2020 programs (InfraDEVSUP II Euro-BioImaging, RIA Global BioImaging, Cost projects....).

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Privileged contractual relationships with 1) major companies in the field (Nikon, Leica, Zeiss, Roper Scientific/Photometrics, GE Healthcare, Technicolor, 3i, Brucker, Konica Minolta...); 2) many French SME-SMI, developing innovative systems (BioAxial, Imagine Optics, Fluigent, Innopsys); 3) young national startups (Alveole, CryoCapCell, GATACA Syst, Twinkle).

DATA

Estimated volume stored in 2017: 500 To

Estimated volume stored in 5 years: 5,000 To

Data access: restricted

Restrictions: users own the data: access in "project sharing" mode, with limited number of collaborators. For "public data" (eg published data), either "read only" or "shared" mode.

Full cost

19.4 M€ in 2016

Personnel

115.3 FTE in 2016

International dimension

EuBI, ESFRI Project

Director General: John Eriksson (ERIC seat), Jan Ellenberg (BioHub), Silvio Aimé (MedHub)

Coordinating countries: Hub Tripartite (Finland-ERIC seat, EMBL Bio-Hub, Italy Med-Hub)

Partner countries: AT, BE, BU, CZ, FR, HR, ISR, IT, NL, NO, PL, PT, ES, UK, SK

Website: www.eurobioimaging.eu

F-CRIN



French Clinical Research Infrastructure Network

Established in 2012, "F-CRIN" was one of the prizewinners in the call for projects: "National Infrastructures in Biology and Health" launched in 2010 as part of the "Investments for the Future". It is also the French component of the ERIC "ECRIN/European Clinical Research Infrastructure Network", and as such, is its national point of entry. The purpose of F-CRIN is to strengthen the achievements of French clinical research, and therefore its international attractiveness and involvement in calls for European projects and multinational clinical and translational trials. F-CRIN is a "support infrastructure", assisting and supporting investigators and academic, hospital and industrial sponsors. It has no sponsorship function.

F-CRIN is a distributed infrastructure combining 17 components (4 more investigation networks labelled from 1/1/2018):

- 4 national platforms (2 generalist; 2 specialized: medical devices and rare diseases) having the critical mass to offer the "Investigator/Sponsor" tandem a full menu of services, from assisting with the design and installation of clinical trials to the analysis of the collected data;
- 12 networks of excellence in clinical research, each displaying an original internationally attractive scientific programme, in a targeted theme having strong development potential, with a collective scientific and methodological expertise and a strong investigation capacity;
- a coordination node located in Toulouse, which ensures the national representation for the F-CRIN Infrastructure and provides some common-interest services.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

At the end of 2017 the Infrastructure F-CRIN with its 13 components (national coordination included) has been part of 536 clinical trial studies with 312 studies on going or closed, and 106 new studies in 2017 (+24.65%/2016).

DATA

The infrastructure does not store the data

Data access: restricted

Restrictions: as F-CRIN isn't a legal entity, it can't be the owner of data it contributes to produce

Full cost

6.2 M€ in 2016

Personnel

71.9 FTE in 2016

International dimension

ECRIN, ESFRI Landmark

Coordinator: Jacques Demotes

Coordinating country: France

Partner countries: CZ, DE, HU, IT, NO, PT, ES; Observers: CH, SK

Website: www.ecrin.org



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Toulouse

Other sites: The F-CRIN distributed infrastructure has 17 components since 1st January 2018 (with the labeling of 4 new investigation networks) with bridgeheads throughout the country

French supporting institution: INSERM

Director: Vincent Diebolt

Construction: **Operation:**

2012

2012

Stakeholders in France: The AP-HP and the Bordeaux University Hospital are signatories with Inserm of the F-CRIN Consortium Agreement (October 2016). Toulouse University Hospital, Toulouse 3 ("Paul Sabatier") University and Inserm are members of UMS 015, National Coordination of Distributed Infrastructure "F-CRIN"

Contact in France:

olivier.rascol@univ-tlse3.fr

vincent.diebolt@inserm.fr

www.fcrin.org

France Life Imaging



Category: RI

Type of infrastructure: Distributed

Infrastructure location: CEA-Centre
Paris-Saclay

Other sites: Paris, Lyon, Bordeaux, Grenoble,
Marseille, Rennes, Saclay

French supporting institution: CEA

Director: Jacques Bittoun

Construction: Operation:

2012

2012

Stakeholders in France: CNRS, INSERM,
INRIA, AMU, Université de Bordeaux,
Université Claude Bernard - Lyon 1, UGA,
Université Sorbonne Paris Cité

Contact in France:
jacques.bittoun@cea.fr

www.francelifeimaging.fr

FLI's goal is to provide services to the in vivo imaging community (clinicians, academic and industrial partners) and to coordinate research in key domains of in-vivo imaging (interventional imaging, agents, instrumentation and image management and processing). With its very innovative equipment (such as the first Electronic Paramagnetic Resonance system for humans, the first multimodal system associating Positron Emission Tomography and Ultra-Sound ever installed in France) at disposal, FLI currently conducts studies to evaluate their benefit for the clinical research and the patient care.

These devices reinforce the state of the art imaging equipment already installed to offer access to all modalities (MRI, optical imaging, PET, US, intravital imaging) for preclinical studies (57%) and clinical studies (43%). Associated expertise includes neurosciences, cancer, cardiometabolic and infectious diseases.

FLI proposes solutions for information analysis and data management that meet the needs of the clinical and preclinical research. A strong focus is put on the interoperability of the already acquired imaging data sets.

The supply of services for preclinical and clinical research is consolidated by a quality approach common to all platforms operators and the establishment of operating accounts. Finally, the expertise of operators is maintained or even strengthened through the establishment of new training (Molecular Imaging, US, metrology for imaging) and by training PhD students and professionals.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

FLI and the imaging facilities provide an easy access to the industrial partners through research contracts or specific partnerships:

- the creation of a joint academic and industrial laboratory, Labcom Glnesis is an example;
- the integration to Carnot Institutes (STAR, Télécom et Sociétés numériques or Cognition);
- the coordination of European programs involving industrial partners (M-CUBE or SPCCT).

DATA

Estimated volume stored in 2017: 2,000 To

Estimated volume stored in 5 years: 50,000 To

Data access: full

Full cost

**55.9 M€ in 2016
(including Neurospin)**

Personnel

**313.6 FTE in 2016
(including Neurospin)**

FRANCE GENOMIQUE



National Genomics and Associated Bioinformatics Infrastructure

The France Génomique infrastructure affords to the French scientific community (both from the public and private sectors), an access to the best national platforms and the opportunity to participate in ambitious projects at the best national and international levels.

Its unified governance, a single entry point for managing large and medium size projects and the sharing of equipment and skills enable the structuring of the community into a critical mass. This allows meeting the growing needs in sequencing, storage and processing of data and the development of innovative tools.

France Génomique provides:

- leading expertise in genomics and associated bioinformatics technologies;
- competitive services in genomics and bioinformatics (in coordination with the IFB research infrastructure);
- a very wide dissemination of expertise to the life sciences community as a whole.

France Génomique aims to guarantee France a high level of competitiveness and independence in the field of genomic data production and data analysis technology at a time when this technology has never been more strategic to all areas of research in the life sciences.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

At the heart of the technological revolution in genomics, France Génomique offers French research, public or private, the possibility of maintaining its competitiveness by having permanent access to the best level of the international state of the art in this field. France Génomique is thus a key player in major genomics projects with a strong socio-economic impact, in all areas of life sciences: human genetics and medicine, environment and ecology, agronomy, etc.

DATA

Estimated volume stored in 2017: 3,000 To
 Estimated volume stored in 5 years: 20,000 To
 Embargo period: 6 months
 Data access: full

Full cost

39.9 M€ in 2016

Personnel

184.9 FTE in 2016



Category: RI

Type of infrastructure: Distributed

Infrastructure location: CEA/IBFJ/Genoscope

Other sites: Castanet-Tolosan, Illkirch, Valbonne
 Sophia-Antipolis, Paris, Montpellier, Marseille,
 Villeurbanne, Rennes, Jouy-en-Josas, Versailles,
 Orsay, Villeneuve d'Ascq

French supporting institution: CEA

Director: Pierre Le Ber

Construction: Operation:

2011

2011

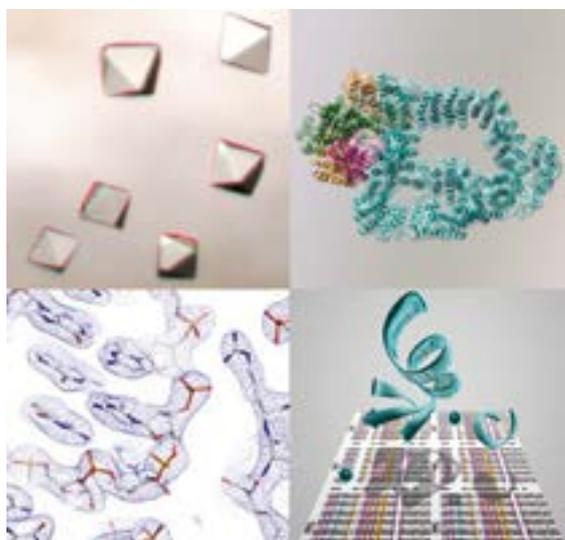
Stakeholders in France: CNRS, INRA,
 INSERM, INRIA, Institut Pasteur, AMU,
 ENS ULM, Université Claude Bernard - Lyon 1,
 Université de Strasbourg, Université Lille 1 -
 Sciences technologies

Contact in France:

pleber@genoscope.cns.fr

www.france-genomique.org/spip

French Infrastructure for Integrated Structural Biology



Category: RI

Type of infrastructure: Distributed

Infrastructure location: IGBMC Strasbourg/
Illkirch

Other sites: Grenoble, Montpellier, Marseille,
Paris Sud

French supporting institution: CNRS

Coordinator: Bruno Klaholz

Construction: Operation:

2011

2012

Stakeholders in France: CEA, INSERM, AMU,
UGA, Université de Montpellier, Université
de Strasbourg, Université Paris-Sud

Contact in France:
contact@frisbi.eu

frisbi.eu

Integrated Structural Biology allows the combination of different approaches to access structural and dynamic information at various size and time scales and thus improves our understanding of the dynamic mode of interaction of biological macromolecules and of their functional complexes, of pathogens with their environment and thus to understand the mechanisms that govern the functioning of healthy cells and document the link between deregulation and molecular pathology.

The French Infrastructure for Integrated Structural Biology, FRISBI, distributed across 5 nodes (Strasbourg, Grenoble, Montpellier, Marseille and Paris South) provides academic and industrial, national and European users involved in integrated structural biology projects peer-reviewed access to a broad range of state-of-the-art technologies and advanced know-how in the areas of: - sample production using in vitro, prokaryotic and eukaryotic systems - biophysical characterization - crystallization - crystallography including links with synchrotrons ESRF and SOLEIL - electron microscopy - super resolution fluorescence microscopy - NMR - spectroscopies.

FRISBI also has a training mission in structural biology, in connection with the ReNaFoBis (National training network in integrative structural biology) initiative www.renafobis.fr for the training of PhD students and post-doc researchers.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

FRISBI is an infrastructure open for access to manufacturers. In addition, many partnerships with industry have been implemented for technological development such as the automation of electron microscopy image collection, automatic screening of ligands by X-ray crystallography and tests of new detectors. FRISBI has collaborations with several industries in biotechnology. Start-ups have been created and new ones are in the process of implementation.

DATA

Estimated volume stored in 2017: 1,500 To

Estimated volume stored in 5 years: 8,000 To

Data access: full

Full cost

12.8 M€ in 2016

Personnel

63.3 FTE in 2016

International dimension

Instruct, ESFRI Landmark

Director: David Stuart

Coordinating country: United Kingdom of Great Britain

Partner countries: BE, DK, FR, IS, IT, NL, PT, CZ, SL

Website: www.structuralbiology.eu

IBISBA-FR



Industrial Biotechnology Innovation and Synthetic Biology Acceleration

IBISBA-FR is a distributed (Ile de France, Toulouse region...) intermediate stage (TRL2-5) R et D infrastructure.

Its key missions are to (i) promote industrial biotechnology and underpin the development of the bioeconomy fostering applications to the renewable carbon sector. (ii) catalyze scientific innovation and (iii) create a continuum between fundamental science and industrial implementation of biotechnology. IBISBA-FR is composed of a series of technical platforms (bioinformatics, high-throughput strain engineering, analytical methods, unit operations, biotransformations and fermentation). These are completed by services linked to environmental sustainability analysis and practical ethics. IBISBA-FR works closely with industry. This is well-illustrated by its central hub TWB (a biotechnology pre-industrial demonstrator), which is associated with an extensive public-private partnership involving 23 companies. IBISBA-FR provides R et D services including: the funding and hosting of high-risk, R et D projects that are designed to allow public researchers to rapidly generate IP and provide the basis for the creation of start-ups; one-to-one R et D offers for companies wishing to advance their biotechnology projects towards industrialization; multiple R et D offers for National and European funded consortia.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The IBISBA-FR infrastructure offer services related to industrial biotechnology. The various platforms and facilities are largely accessible to socioeconomic partners, and coordination intrinsic to IBISBA-FR provides the ability to offer integrated services. This simplifies the conception and management of innovation projects requiring multiple platform accesses. The IBISBA-FR ambition is to accompany innovation projects along the TRL scale from 2 to 5.

DATA

Estimated volume stored in 2017: 5 To

Estimated volume stored in 5 years: 50 To

Data access: restricted

Restrictions: presently, the systematic sharing of data generated by the different IBISBA-FR components is considered to be the default option.

Full cost

11.7 M€ in 2016

Personnel

74.9 FTE in 2016

International dimension

IBISBA-EU

Coordinator: Michael O'Donohue

Coordinating country: France

Partner countries: BE, DE, ES, FI, GR, IT, NL, UK

Website: www.ibisba.com



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Ramonville Saint-Agne

Other sites: Saint-Nazaire, Toulouse, Évry, Saint-Paul-lez-Durance, Jouy-en-Josas

French supporting institution: CNRS, CEA, INRA, INSA Toulouse, Université de Nantes

Director: Michael O'Donohue

Construction: Operation:

2016

2018

Contact in France:

michael.odonohue@inra.fr

www.toulouse.inra.fr/Toutes-les-actualites/Projet-IBISBA

Infectious Disease Models and Innovative Therapies



Category: RI

Type of infrastructure: Single site

Infrastructure location: Fontenay-aux-Roses

French supporting institution: CEA

Director: Roger Le Grand

Construction: Operation:

2012

2012

Stakeholders in France: INSERM, Institut Pasteur, Université Paris-Sud

Contact in France:
roger.legrand@cea.fr

www.idmitcenter.fr

IDMIT has strong expertise and skills in models for human infectious diseases (non human primates - NHP - in particular). Scientists at IDMIT work on pathogenesis, treatment, prevention and vaccines. IDMIT extends the long lasting expertise of partners in the development of NHP models of HIV infection and AIDS to human diseases like Flu, chikungunya virus, dengue virus, yellow fever, Hepatitis, Ebola, Malaria, whooping cough, Chlamydia infection and Tuberculosis.

IDMIT has been partner of several European collaborative projects from FP5 to FP7 and is now involved in H2020 programs.

The infrastructure gathers core facilities including extended BSL2 and BSL3 laboratories and animal facilities. Core labs are equipped for molecular and cellular biology, cells sorting and cytometry (including mass cytometry). Technologies developed at IDMIT for in vivo studies include endoscopy, echography, radiography, as well as unique in vivo imaging technologies adapted to NHP studies like near infrared fluorescence (NIR), confocal-endo microscopy, two-photon microscope and whole body PET-CT for NHP.

The combination of these equipments with confined facilities for studies of experimentally infected animals is unique in Europe.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

IDMIT is collaborating with international pharmaceutical industries implicated in infectious diseases research and innovation: Sanofi-Pasteur, GlaxoSmithKline, Merck... These collaborations are performed under partnerships, research collaborations or services format. IDMIT is also collaborating with national and European SMEs working in vaccines and innovative therapies fields.

DATA

Estimated volume stored in 2017: 50 To

Estimated volume stored in 5 years: 500 To

Data access: full

Full cost

—
4.5 M€ in 2016

Personnel

—
32.2 FTE in 2016

International dimension

IDMIT

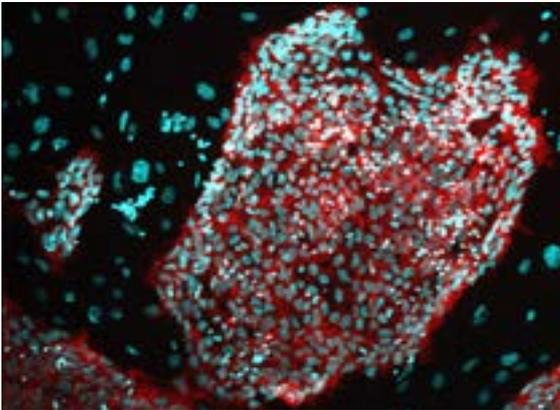
Director: Roger Le Grand

Coordinating country: France

Partner countries: DE, AU, AT, BE, BR, CU, DE, DK, ES, USA, GA, IR, NL, UK, SE, MU

Website: www.idmitcenter.fr

Pluripotent Stem Cell and Tissue Engineering



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Villejuif

Other sites: Évry, Montpellier, Strasbourg, Lyon

French supporting institution: INSERM

Director: Annelise Bennaceur-Griscelli

Construction: Operation:

2012

2015

Stakeholders in France: Université Paris-Sud, CNRS, Université de Strasbourg, Université d'Évry-Val d'Essonne, CHU Montpellier

Contact in France:
annelise.bennaceur@aphp.fr

www.ingestem.fr

The missions of the INGESTEM partners are to promote medical applications of human embryonic (ESC) and induced pluripotent stem cells (iPSC) with the support and expertise of five major French stem cell centers, as pioneering centers in the derivation of the first human embryonic stem cells (ES) in France and leaders in the field of cell reprogramming.

INGESTEM fosters the development of up-to date technologies and stem cell research applications in disease modeling, drug discovery, and protocols of regenerative medicine to translate stem cell research into new therapies within European and international collaborations. Open to academia and industry, INGESTEM facilitates the development of comprehensive set of innovative resources and partnerships on cellular reprogramming strategies, differentiation protocols, high-throughput screening strategies of molecules and scale-up culture of clinical grade cellular products.

ESC and iPSCs are used for genome editing and generation of organoid in the prospect of future innovative therapies and cellular therapies. ESCs and iPSCs from animal models are available to assess the safety and therapeutic competency of ESCs/iPSCs-derived cell grafts.

INGESTEM gathers platforms and facilities in stem cell culture, reprogramming and cell engineering, genomic and genome editing, transgenesis in non-human primates, high throughput screening, and automatized cell factory.

RELATIONS WITH ECONOMIC ACTORS / SOCIO-ECONOMIC IMPACT

- Development of pathological models of IPS/ES in link with university hospitals for research / European programs and pharmaceutical industries.
- Haplobank clinical grade IPSC in link with the internal GAIT network (founding member).
- Patents in Cell Therapy/SATT and Inserm Transfert.
- Partnerships with pharmaceutical industries (Sanofi, Roche, Servier), and Biotech (Miltenyi).
- Creation of 4 start-ups, 1 CDMO.

DATA

Estimated volume stored in 2017: 100 To

Estimated volume stored in 5 years: 500 To

Embargo period: depending on the project

Data access: restricted

Restrictions: limited access to minimal data necessary and sufficient to permit the exploitation of resources.

Full cost

—
4.0 M€ in 2016

Personnel

—
44.8 FTE in 2016

METABOHUB



Development of a distributed coordinated French infrastructure for metabolomics dedicated to innovation, training and technology transfer

With four facilities located in Bordeaux, Clermont-Ferrand, Toulouse and Paris-Saclay the objective of MetaboHUB is to build an open national infrastructure in metabolomics and to integrate the major infrastructure network at the European level. From 2013 to 2017, MetaboHUB has developed analytical tools and methods, web services and databases dedicated for high-throughput metabolomics and fluxomics. These technologies (NMR, LC-MS, GC-MS, statistics, bioinformatics) allow high-throughput biochemical phenotyping of large sample sets, analysis of the metabolome (biological fluids of human cohorts, plant, animals, micro-organisms extracts...) and high-throughput measurement of metabolic fluxes in prokaryotic and eukaryotic cells. Since 2017, the infrastructure has provided standardized methods, an ecosystem of data mining tools (Workflow4Metabolomics) and bioinformatic resources to reconstruct metabolic networks (MetExplore), to academic and private partners. The release of a spectral database (PeakForest) is currently in preparation. Several partnerships with national infrastructures are currently going on to strengthen the French offer in integrated omics data production and analysis.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Services FR (2017): 118, SMEs: 1-5; international level: 11; industrial research contracts: 2 technological co-developments. MTH participates in 1 Labcom and FUI projects; in the competitiveness clusters Nutravita, Céréales Vallée and Innovianides; at Carnot 3BCar and Qualiment institutes; at the SATT Paris-Saclay; 2 transfer structures are backed (POLYPHENOLS Biotech Bordeaux, LEB Aquitaine Transfert). MTH has a know-how transfer agreement with Medday. Link with TWB-IBISBA.fr

DATA

Estimated volume stored in 2017: 80 To

Estimated volume stored in 5 years: 160 To

Embargo period: maximum 60 months, according to the consortium agreements of the EU or national projects. 5 years maximum including private access.

Data access: restricted

Restrictions: Cases of access with the use of data to establish exploratory analysis strategies with partners outside MetaboHUB. According to the case, the restriction is subject to an agreement.

Full cost

10.4 M€ in 2016

Personnel

64.2 FTE in 2016

International dimension

PhenoMeNal

Coordinator: Christoph Steinbeck

Coordinating country: United Kingdom of Great Britain

Partner countries: CH, DE, ES, IT, NL, UK, SE

Website: phenomenal-h2020.eu/home



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Villenave-d'Ornon

Other sites: Paris, Toulouse, Bordeaux, Clermont-Ferrand

French supporting institution: INRA, CEA

Director: Dominique Rolin

Construction: Operation:

2013

2018

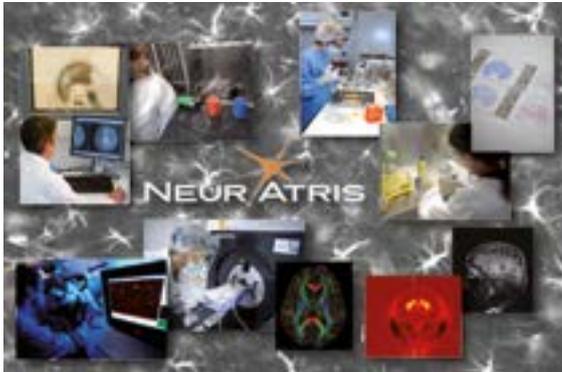
Stakeholders in France: CNRS, INSERM, INSA Toulouse, UB, UCA, Université de Toulouse 3 – Paul Sabatier, Sorbonne Université

Contact in France:

dominique.rolin@inra.fr

www.metabohub.fr

Translational Research Infrastructure for Innovative Therapies in Neuroscience



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Fontenay-aux-Roses

Other sites: Orsay, Gif-sur-Yvette, Paris, Le Kremlin-Bicêtre, Créteil, Évry, Nantes

French supporting institution: CEA

Director: Philippe Hantraye

Construction: **Operation:**

2012

2012

Stakeholders in France: INRA, INSERM, UPEC, ICM, AP-HP

Contact in France:
lauranne.duquenne@cea.fr

neuratris.com

Relying on 5 key research centers located in the Paris area and Nantes, NeurATRIS represents one of the largest concentrations of neuroscientists in Europe. Gathering in one institute without walls MIRCen, SHFJ and Neurospin from the CEA, the Brain and Spine Institute, the BIRD consortium, the Henri Mondor and Bicêtre Hospitals, all with internationally-recognized skills and expertise in biotherapies and neurodevelopmental disorders, NeurATRIS positions itself as the largest European infrastructure conducting R et D projects and providing services to academic, clinicians and industry in neurosciences.

NeurATRIS triggers strong and durable partnerships, public and private, along three axes:

1. developing specific lines of translational research and know-hows in Neuroscience, aiming at discovering and qualifying new therapeutic solutions for neurodegenerative disorders at the preclinical and clinical levels;
2. overcoming fragmentation in gathering various specialists of cell, gene and drug-based technologies, thus enabling cross-functional fusion of skills and expertise in a single structure;
3. facilitating access to state-of-the-art platforms through an unique access point along with highly trained personnel to academic, clinical and industrial sectors. Selected external academic or industrial projects will transit between the different centers - depending on their stage of development and required expertise - under the supervision of a dedicated translational research project manager.

DATA

Estimated volume stored in 2017: 700 To

Estimated volume stored in 5 years: 6,000 To

Data access: restricted

Full cost

14.3 M€ in 2016

Personnel

58.8 FTE in 2016

International dimension

EATRIS, ESFRI Landmark

Director: Anton Ussi

Coordinating country: Netherlands

Partner countries: CZ, EE, ES, FI, FR, IT, LU, LV, NO, SE, SI

Website: eatris.eu

NEUROSPIN



France's research center for innovation in brain imaging technologies, with a motto: "shed light on the singularity of the human brain, its development, and its pathologies"

NeuroSpin offers to the French scientific community (both public and private) the possibility to acquire new knowledge on the brain, and specifically on the human brain, by proposing an access to break-through methodologies in brain imaging and in neuro-computing.

NeuroSpin develop and provide to community. The offer fits the following NeuroSpin missions:

- analyse the human brain functions, their development in babies and children, and the impact of culture and education;
- identify biomarkers and mechanisms of neurological, psychiatric and neurodevelopmental diseases;
- compare the human brain with others animal species;
- develop and test imaging methods at different scales of observation: by Magnetic Resonance Imaging (MRI), by electro- and magneto-encephalography (EEG and MEG), by massively parallel electrophysiology or photon imaging;
- develop softwares for processing and modelling of large datasets in neuro-imaging.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

NeuroSpin offers French research, public or private, the possibility of maintaining its competitiveness by having permanent access to the best level of the international state of the art of imaging technologies dedicated to brain research for application in medicine, health and education with earlier diagnostic of neurological diseases, and to study the normal and pathological development of brain.

DATA

Estimated volume stored in 2017: 500 To

Estimated volume stored in 5 years: 5,000 To

Embargo period: 60 months

Data access: full



Category: RI

Type of infrastructure: Single site

Infrastructure location: CEA Saclay

French supporting institution: CEA

Director: Stanislas Dehaene

Construction: **Operation:**

2007

2007

Stakeholders in France: INSERM, INRIA

Contact in France:

stanislas.dehaene@cea.fr

joliot.cea.fr/drf/joliot/Pages/Plateformes_et_infrastructures/plateformes_imagerie/plateforme-neurospin.aspx

Preindustrial Gene Therapy consortium



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Évry

Other sites: Saint-Herblain, Nantes

French supporting institution: Génethon, Genosafe, EFS-ABG, CHU-Nantes

Director: Frédéric Revah

Construction: Operation:

2011

2013

Contact in France:
frevah@genethon.fr

pgt-consortium.fr

The PGT consortium ambition is to play a central role in the international arena for the production of gene therapy vectors which are indispensable for a large number of clinical trials currently taking place in the domain of biotherapies. The role of the consortium is to validate bioproduction procedures at a preindustrial scale, which is a prerequisite for the industrialization of manufacturing processes for gene therapy products and the emergence of a real industrial strategy for the production of gene therapy treatments.

PGT has a double objective: to accelerate the development of methods for vector production and quality control based on pharmaceutical norms and to respond to the growing demand for therapeutic vectors for clinical trials for rare diseases, which are becoming more and more frequent world-wide.

With this in mind, the action of the PGT consortium is based on applications of proof of concept: from preclinical regulatory studies to phase I/II clinical trials.

The mission of the consortium is to deliver gene therapy products for phase I/II studies to academic investigators or industrials.

The consortium is composed of four first-class actors in the domain of gene therapy and bioproduction in France: Genethon, GenoSafe, Atlantic BIO GMP and a University Hospital Center.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Use of the infrastructure by academic and industrial partners (20% et 80% respectively). Creation of few new jobs and the retention of existing ones in the areas of Nantes and Paris.

DATA

Estimated volume stored in 2017: 50 To

Estimated volume stored in 5 years: 200 To

Data access: restricted

Restrictions: access to third parties is restricted to user with which the contract has been signed. Access only to data that concern the user.

Full cost

—
5.3 M€ in 2016

Personnel

—
26.6 FTE in 2016

Proteomics French Infrastructure

ProFI is a national infrastructure combining the three leading French laboratories in the field of Proteomics. The technological and methodological developments pursued in ProFI aim at detecting and quantifying proteins present in complex biological samples, at studying their dynamics and their post-translational modifications.

Applications for these developments include the detailed elucidation of the molecular mechanisms involved in major cellular functions, and the discovery and assessment of new biomarkers of disease. Mastering the most advanced approaches allows ProFI to efficiently meet the numerous requests from academic and industrial collaborators.

ProFI also carries out training actions to transmit new skills to the French proteomics community, e.g. to allow proteomics platform operators to get to grips with the software environment developed at the infrastructure to optimize the management and the analysis of the data.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

ProFI works with about 30 partners in pharmaceutical (protein biomarker research, drug development, vaccine evaluation), agri-food and biomanufacturing industries. ProFI provides these manufacturers with access to a variety of technologies and methodologies and its advanced know-how. ProFI generated 11 patents (2012-2017) and contributed to the creation of the "Promise Advanced Proteomics" and "Syndivia" start-ups.

DATA

Estimated volume stored in 2017: 250 To

Estimated volume stored in 5 years: 2,000 To

Data access: restricted

Restrictions: before the publication of the results, the data are only accessible to the data producers and our collaborators who provided the samples.

Full cost

—
8.8 M€ in 2016

Personnel

—
77.2 FTE in 2016



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Institut BIG, CEA/Grenoble

Other sites: Toulouse, Strasbourg

French supporting institution: CNRS

Director: Jérôme Garin

Construction: Operation:

2012

2012

Stakeholders in France: CEA, INSERM, UGA, Université fédérale de Toulouse Midi-Pyrénées, Université de Strasbourg

Contact in France:

jerome.garin@cea.fr

www.profi-proteomics.fr

Central Analyser of Data



Category: Project

Type of infrastructure: Virtual

Infrastructure location: Paris

French supporting institution: INSERM

Coordinator: Franck Lethimonnier

Construction: Operation:

2018

2020

Stakeholders in France: CEA, INRIA

Contact in France:

franck.lethimonnier@inserm.fr

www.aviesan.fr/aviesan/accueil/toute-l-actualite/plan-france-medecine-genomique-2025

The Central Analyser of Data (CAD) project is at the heart of the France Genomic Medicine 2025 Plan. The CAD will be by 2020 the infrastructure for collecting, analysing, interpreting and storing genomic data at the national level, constituting a unique knowledge base. The main strategic goal is to provide access to genomic medicine.

The CAD will be organized around a Central CAD, bringing together tools of calculations and analyses the files of variants collected and annotated, clinical data and care necessary for the interpretation. Alongside this central CAD, e-CAD will provide interfaces dedicated to user categories remotely accessible whether for the care – the e-cad orchestrator – or for research – the portal e-cad. The e-cad portal will offer several services to research: reception desk, assistance and advice on project design, access to data sets and tool libraries, provision of virtual machines, hosting/storage of genomic data and associated data, support and methodological tools, statistical analysis, data transfers.

The research communities that will be using the CAD are: Genetics/ Genomics, Biological Systems at the Molecular Level, Pharmacology, Biomarkers and Companion Diagnostics, Physiopathology and Disease Nosology, Clinical Research, Epidemiology, Data Science, Infrastructure and Architectures, Technologies and Software Engineering, numerical stimulation and modeling.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The CAD represents a major economic challenge firstly because it will allow massive savings to our healthcare system (decrease in the number of unnecessary diagnostic assessments, optimization of the use of drugs, etc.) and secondly, by developing a new industrial sector by offering a unique service infrastructure to industry. A common working group involving 50 company representatives including pharmaceutical, diagnostic and digital industries as been set up to discuss this issues.

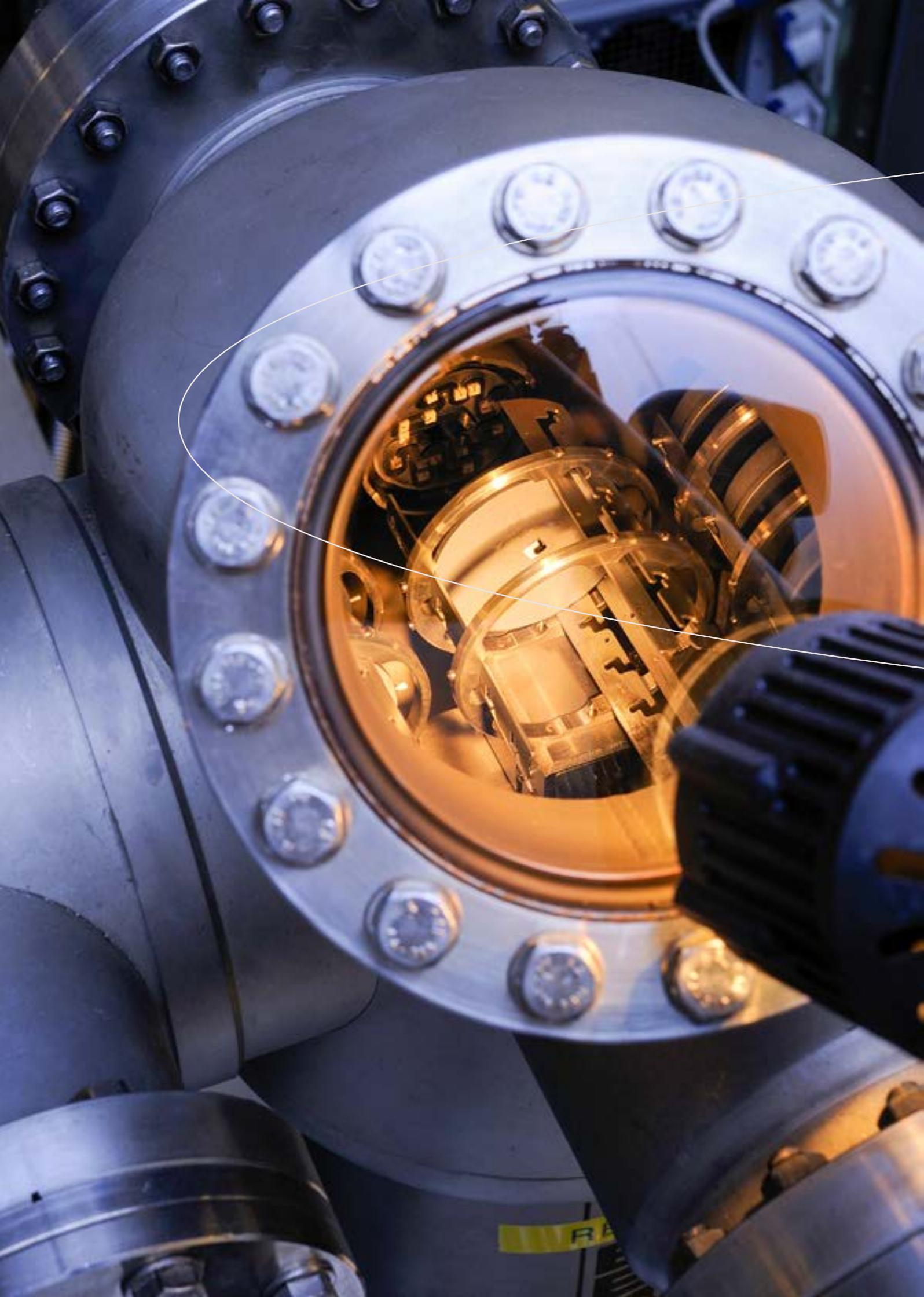
DATA

Estimated volume stored in 2017: 15,000 To

Estimated volume stored in 5 years: 70,000 To

Data access: restricted

Restrictions: conditioned



MATERIAL SCIENCES AND ENGINEERING



Material sciences and engineering

The field of the material sciences and engineering aims to provide scientific communities with exceptional and even unique research tools to develop the knowledge of matter at various scales from the atom to the macroscopic level and in all of its forms (gas, solid, liquid, plasma). Advances in knowledge require reproducing, in laboratory, increasingly extreme conditions of pressure, temperature and magnetic field. To meet these needs, research infrastructures offer a very wide range of probes: incoherent photons, covering the widest electromagnetic spectrum, millimeter waves with very hard X-rays, even gamma rays; coherent photons, delivered by high power lasers; neutrons... The largest infrastructures that generate extremely intense beams of particles like synchrotron radiation, neutrons, lasers, are "monosite" and international for the majority. A large number of distributed infrastructures enable globally competitive instruments to be networked together associated to an international scientific expertise in the service of the scientific community.

All the infrastructures in the material sciences correspond to approaches and techniques of analysis very complementary which concern all the scientific domains: physics, chemistry, astrophysics, geology, biology, archeology, paleontology and cultural inheritance. Thus, these infrastructures help to answer the most fundamental scientific questions while participating in advances in more applied fields such as energy or health. By enabling the characterization of materials, they contribute, in particular, to the development of nanoelectronics and nanosciences.

Synchrotron sources have, in recent years, increased their scientific capacities and their reception capacities. At the French level, the **ESRF** and **SOLEIL** present the analytical techniques that count the most users but the French community is ready to exploit the many perspectives offered by **XFEL** particularly in the fields of matter and life sciences.

Neutron scattering is an often complementary X-ray analysis technique with nearly a thousand French users mainly distributed between **Orphée/LLB** and **ILL**. The next decade will see a clear evolution of the French neutronic landscape with the short-term closure of the Orphée reactor and in the longer term, the gradual start of **ESS** from 2023. The **ILL** is destined to remain a reference neutron source at the world level.

At the level of laser installations, the coming years will witness a rise in power of **APOLLON** and **PETAL**, installations with worldwide unique characteristics that will allow advances in the fields respectively of the very high intensity physics, the radiation interaction subject to extreme intensities... and the physics of fusion and high energy densities.

In addition to these large facilities, the subject sciences have a fleet of very high performance distributed platforms open to the national scientific community (**METSA**, **THCNMR**, **RENARD**, **FT-ICR**). The challenge at the national level is to carry out a coordination policy in order to keep instrumentation at the highest level, diversified and open to a very multidisciplinary community.

LNCMI and **EMIR**, at the interface between very large facilities and distributed platforms, are respectively developing extremely intense magnetic fields and irradiation facilities, needed for a large number of scientific sectors.

Finally, in the field of engineering and development of nanoscale technologies that require tools for synthesis and observations, the national network of large nanotechnology facilities (**RENATECH**) is a competitive and growing tool at the world level in micro and nano-manufacturing.


**RESEARCH INFRASTRUCTURES
MATERIAL SCIENCES AND ENGINEERING**

CATEGORY	NAME	FULL NAME	ESFRI
VLRI	ESRF	European Synchrotron Radiation Facility	ESRF Upgrade Ph 1 (2006) ESRF Upgrade Ph 2 (2016)
VLRI	ESS	European Spallation Source	ESS (2006)
VLRI	ESS	European Spallation Source	ILL Upgrade Ph 1 (2006)
VLRI	ILL	Institut Max von Laue - Paul Langevin	
VLRI	Orphée/LLB	ORPHEE reactor/Laboratoire Léon Brillouin	
VLRI	Soleil	Soleil synchrotron	XFEL (2006)
VLRI	XFEL	European X-ray Free Electron Laser	
RI	APOLLON	Laboratory for the Use of Intense Lasers	
RI	EMIR	French Accelerator Network for Material Irradiation	
RI	ERIH ^S -FR ¹	European Research Infrastructure for Heritage Science	ERIH ^S (2016)
RI	FT-ICR	High field FT-ICR mass spectrometry national network	
RI	LNCMI	National high magnetic field laboratory	EMFL (2008)
RI	METSA	Transmission Electron Microscopy and Atom Probe	
RI	PETAL	PETAwatt Aquitaine Laser	
RI	RMN-THC	High-field nuclear magnetic resonance research infrastructure	
RI	Renard	National interdisciplinary EPR network	
RI	RENATECH	National network of large academic nanofabrication centers	

¹ RI at the interface with the sector "Social Sciences and Humanities". RI description can be found in the sector "Social Sciences and Humanities".

European Synchrotron Radiation Facility



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Grenoble

French supporting institution: CNRS, CEA

Director General: Francesco Sette

Construction: Operation:

1988

1994

Contact in France:
sette@esrf.eu

www.esrf.eu

The ESRF is the European synchrotron radiation source producing high-energy X-rays (hard x-rays ranging from 10 to 300 keV) which are distributed over 43 experimental stations available to the scientific community, which benefit an advanced instrumentation. The mission of the ESRF is to provide the scientific community with access to these beamlines, which benefit from state-of-the-art scientific instrumentation and scientific expertise, and to develop new methods and technologies. The fields of application are extremely vast: life sciences, biology and medical applications, soft matter sciences, chemistry and physics, environmental sciences and cultural heritage. The ESRF is the undisputed leader among the synchrotron facilities in Europe, even worldwide. Phase I of the ESRF Upgrade Programme (2009-2015) has been completed, with an enhanced performance of the accelerator and improved beam properties, the creation of 8 new generation beamlines, representing 19 experimental stations. Phase II, the ESRF-EBS (2015-2022) foresees the complete reconstruction of the storage ring, which will allow an increase in brilliance by a factor of 100. The project includes the construction of four new beam lines and a broad programme of detector development together with "data as a service" strategy. Similar programmes are already in advanced study in the US, Japan and China.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Partnerships and interaction with industry are present at different levels: commercial contracts with industrials (2 M€ of yearly income), joint conception and development of innovative devices (>30 technology transfer licences), economic return: evaluated since 1988 to over 2 B€ spent in the commercial and industrial sectors, 80% of which stay in the French economy.

DATA

Estimated volume stored in 2017: 2,400 To

Estimated volume stored in 5 years: 15,000 To

Embargo period: 36 months

Data access: restricted

Restrictions: creation of an ESRF account and quote of the authors of the original data.

Full cost

—
28.9 M€ in 2016

Personnel

—
**682.9 FTE in 2016
(for the VLRI)**

International dimension

ESRF, Landmark ESFRI

Director General: Francesco Sette

Coordinating country: France

Partner countries: ZA, DE, AT, BE, DK, ES, FI, FR, HU, IN, IL, IT, NO, NL, PL, PT, CZ, UK, RU, SK, SE, CH

Website: www.esrf.eu

European Spallation Source ERIC

The European Spallation Source ESS will be a multidisciplinary research infrastructure using the most powerful source of neutrons in the world to explore matter in many areas from life sciences to materials engineering, from cultural heritage to magnetism. ESS will be about 30 times more powerful than existing facilities and will offer new opportunities for research in the fields of magnetism, ultra-high resolution spectroscopy (10^{-8} eV), particle physics through the use of ultra-cold neutrons, and also in more applied fields such as health, environment, energy, climate, transport, pharmacy. ESS consists of a linear accelerator, 600 meter long, which produces protons at an energy of 2.5 GeV impinging a tungsten target with a beam power of 5 MW. This source will produce long neutron pulses (2.86 ms at a frequency of 14 Hz with peak current of 62.5 mA) offering a peak flux 30 times higher than the American spallation source SNS (short pulses). ESS should produce its first neutrons end of 2019, and operate at full power in 2023-2025 with 15 scientific instruments.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Creation around the ESS and the MaxIV synchrotron of a site gathering research, university and industrial facilities linked to research and innovation.

DATA

Estimated volume stored in 2017: 0 To

Estimated volume stored in 5 years: 10,000 To

Embargo period: 36 months

Data access: full

French contribution to construction

—
147.4 M€ in € 2013

International dimension

ESS, ESFRI Landmark

Director: John Womersley

Partner countries: DE, DK, ES, EE, FR, HU, IT, LT, NO, NL, PL, CZ, UK, SE, CH

Website: europeanspallationsource.se



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Lund, Sweden

French supporting institution: CNRS, CEA

Infrastructure representatives in France:

Pascal Debu, Emmanuelle Lacaze

Construction: **Operation:**

2014

2023

Contact in France:

pascal.debu@cea.fr

emmanuelle.lacaze@cnrs-dir.fr

europeanspallationsource.se

Institut Laue-Langevin



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Grenoble

French supporting institution: CNRS, CEA

Director General: Helmut Schober

Construction: Operation:

1967

1971

Contact in France:
schober@ill.fr

www.ill.eu/fr

European large-scale research facility, its high-flux neutron source (58 MW) provides neutrons to 40 instruments considered to be amongst the most powerful in the world for research into the structure and dynamics of matter. Scientists from all over the world use ILL's instruments and expertise (some 1,500 researchers perform 800 experiments a year). ILL covers a wide range of science (biology, chemistry, soft matter, fundamental and nuclear physics, materials science and magnetism, etc.).

To maintain this position, the Endurance modernization program planned initially in 2 phases has started since 2016. It concerns numerous instrumental projects and sample environments, the renovation of guides but also the improvement of data processing.

The ILL dominates neutron science, ahead of the most recent European research reactor (Germany's FRM-II), the new American and Japanese spallation sources (SNS and J-PARC), and the UK's ISIS. The ESS in Sweden will be the most powerful spallation source in the world, bringing its first instruments into operation around 2023-2025, with normal operations envisaged from 2030.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Development of contracts with local companies (with CEA-Leti and the ESRF (IRT NanoElec)). The facility is a member of a SATT. As regards employment, the ILL generates (in addition to the ~500 jobs at ILL) 600 induced and indirect jobs in the region and 400 at national level.

DATA

Estimated volume stored in 2017: 150 To

Estimated volume stored in 5 years: 1,500 To

Embargo period: 36 months

Data access: restricted

Restrictions: The data are available but needs to create an IT account and mention ILL when the data are using.

Full cost

—
34.3 M€ in 2016

Personnel

—
**521.7 FTE in 2016
(for VLRI)**

International dimension

ILL, ESFRI Landmark

Director: Helmut Schober

Coordination countries: Germany, France, United Kingdom of Great Britain

Partner countries: AT, BE, DK, ES, IT, PL, CZ, SK, SE, CH

Website: www.ill.eu

ORPHÉE/LLB

Orphée/Laboratoire Léon Brillouin



Orphée reactor is the French national neutron source dedicated to matter characterization. With a 14 MW power, it takes third place among the Europe's installations.

The laboratory Léon Brillouin ensures operation of the neutron beams distributed on experience lines, mainly designed for the study of condensed matter and made available to the scientific and industrial community.

The LLB is both a research laboratory and a laboratory of service and develops its own and recognized scientific activity in the fields of biology/physical chemistry, magnetism and superconductivity, and materials in the broad sense.

Its missions are the design, manufacture and operation of the 24 performing spectrometers installed in Orphée reactor, but also to ensure the coordination of the French technical and scientific contribution to the ESS (European Spallation Source). On the other hand, the LLB provides training (courses, practical work, FAN...) for new users of neutron scattering and offers its expertise to optimize the experiences and the exploitation of the results.

The use of the Orphée/LLB infrastructure represents 60 percent of the total time used by the Neutron scattering French community and generates a very high rate of publication (3rd ranking behind ILL and ISIS).

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Part of the beam time is used for industrial purposes via academic or contractual collaborations with large companies (IFP, LOREAL, AREVA, Michelin, LUMILOG, CILAS...)

DATA

Estimated volume stored in 2017: 25 To

Estimated volume stored in 5 years: 100 To

Data access: restricted

Restrictions: only the persons authorized by the experimental results owner can access to the data.

Full cost

—
29.4 M€ in 2016

Personnel

—
142.2 FTE in 2016



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Gif-sur-Yvette

French supporting institution: CNRS, CEA

Director General: Eric Eliot

Construction: **Operation:**

1974

1980

Contact in France:
eric.eliot@cea.fr

www-llb.cea.fr

SOLEIL Synchrotron



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Gif-sur-Yvette

French supporting institution: CNRS, CEA

Director General: Jean Daillant

Construction: Operation:

2001

2008

Contact in France:

jean.daillant@synchrotron-soleil.fr

www.synchrotron-soleil.fr

SOLEIL is the French national synchrotron facility, located on the Saclay Plateau near Paris. It is a multi-disciplinary instrument and a research laboratory, whose mission is to run research programs using synchrotron radiation, to develop state-of-the-art instrumentation on its 29 beamlines, and to make those available to the scientific community.

SOLEIL, a unique tool for both academic research and industrial applications across a wide range of disciplines (including physics, biology, chemistry, heritage, environment or science of the universe) is used by over 5,000 researchers coming from France and abroad. It is based on a state-of-the-art synchrotron source, both in terms of brilliance and stability. The synchrotron light is emitted by relativistic electrons (with a speed close to the speed of light in vacuum) of very high energy (SOLEIL's nominal energy is 2.75 GeV), which circulate in a storage ring with a circumference of 354 m. SOLEIL radiation spans an energy range from infra-red to hard X-rays, and is optimized for the production of radiation in the medium energy X-ray range.

Due to its high quality beam, SOLEIL (representing approximately 10% of the whole European beamlines) is recognized as a major synchrotron facility in the world.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

SOLEIL develops R et D partnerships and knowledge transfers with industry, and provides companies with high skills and high performance equipment for studying materials. More than 100 projects are achieved each year on its beamlines by dozens of firms. Industrial representatives of the pharmaceutical, automobile, energy, materials and aerospace sectors are members of the Strategic Orientations Committee for Industry at SOLEIL.

DATA

Estimated volume stored in 2017: 370 To; estimation 2018 = 600 To minimum (1,500 To max)

Estimated volume stored in 5 years: 6,000 To minimum (12,000 To estimation max)

Embargo period: maximum 5 years

Data access: restricted

Restrictions: currently, restricted access to the project team and to persons specifically authorized by the project manager. Starting mid-2018, open access after the embargo period.

Full cost

75.5 M€ in 2016

Personnel

359.3 FTE in 2016

European X-ray Free Electron Laser

XFEL is an X-ray source of very high coherence and generating very short pulses. It is still under construction, but a partial operation with one beam line and two experimental stations has started in July 2017. Its brilliance will be a billion times higher than that of the best standard X-ray sources, and very short wavelengths (0.05 nm) will be accessible. Thanks to these characteristics, new research areas will be covered, like viral atomic structure, cell molecular composition, nano-objects 3-D geometry, chemical reactions dynamics, processes going on at the heart of planets.

The operation principle of XFEL is based on a linear superconducting accelerator, 2 km long in a 3.4 km long tunnel, which accelerates the electron bunches at high energy of 17.5 GeV. The electron bunches are then directed through special arrangements of magnets (undulators) in which they emit an increasingly amplified radiation (SASE) until extremely intense and short laser like flashes are created. These flashes of less than 100 fs will open up areas of research that were previously inaccessible: direct observation of atomic moves, time structure analysis, individual particle imaging, structure determination of macromolecules... Six experimental stations will be constructed in a first phase. This infrastructure will be complementary to ESRF and SOLEIL in France.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Together with the CEA and CNRS, a major contribution to the construction of the accelerator of industrial partners Thalès (France) and RI-Research Instruments (Germany) concerns the construction, testing and integration in the clean room of 824 couplers assembled in 103 cryomodules. For the integration of 103 cryomodules, the CEA organized an industrial transfer to Alsyom (France).

DATA

Estimated volume stored in 2017: 1,000 To
Estimated volume stored in 5 years: 50,000 To
Embargo period: 36 months
Data access: full

French participation to construction

—
38.5 M€ in € 2015

International dimension

European XFEL, ESFRI Landmark
Director: Robert Feidenhans'l
Partner countries: DE, DK, FR, HU, PL, UK, RU, SK, SE, CH
Website: www.xfel.eu



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Schenefeld, Germany

French supporting institution: CNRS, CEA

Infrastructure representatives in France:

Maria Faury, Emmanuelle Lacaze

Construction: Operation:

2009

2017

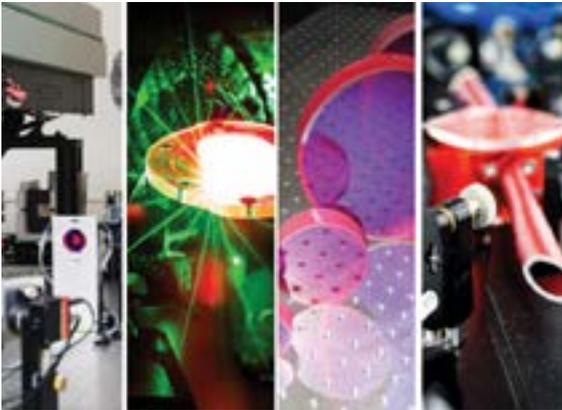
Contact in France:

maria.faury@cea.fr
 emmanuelle.lacaze@cnrs-dir.fr

www.xfel.eu

APOLLON

Laboratory for the Use of Intense Lasers



Category: RI

Type of infrastructure: Single site

Infrastructure location: Palaiseau

French supporting institution: CNRS

Director: Patrick Audebert

Construction: Operation:

1988

2019

Stakeholders in France: CEA, École polytechnique – X, Sorbonne Université

Contact in France:

patrick.audebert@polytechnique.fr

www.apollon-laser.fr

www.luli.polytechnique.fr

The LULI laboratory is the French civil pole of the high-energy power lasers.

It provides to the largest number of French and international users, competitive laser chains at the highest international level, and experimental spaces with advanced instrumentation, adapted for research on the physics of relativistic plasmas. It built the APOLLON facility on the site of "l'Orme des Merisiers" and leads specific developments in order to continuously improve performances of the facilities and meet user demand.

Apollon is a laser facility designed to reach the still unequalled power of 10 petawatts. Thanks to its extreme luminous intensity, it will produce highly relativistic particle beams and X-ray to gamma-ray radiations, allowing pushing back the limits of the fundamental research.

Open to the national and international scientific community on the horizon 2019, operated by LULI the "Laboratoire pour l'utilisation des lasers intenses", Apollon will be an instrument of choice to explore new domains, from the relativistic to vacuum physics, using technologies of acceleration of particles and analysis of matter. APOLLON involves 12 partners and 7 funding agencies of the Plateau de Saclay.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The infrastructure is an important actor in the R & D activities of the Plateau de Saclay with technology transfer activities (Thales) and possible access to the beam for industries.

DATA

Estimated volume stored in 2017: 10 To

Estimated volume stored in 5 years: 50 To

Data access: restricted

Restrictions: plasma data can only be used by those who have obtained them; properties of the principal investigator (PI), they may be communicated to third parties if asked.

Full cost

—
9.3 M€ in 2016

Personnel

—
61 FTE in 2016

French Accelerator Network for Material Irradiation

The French network of accelerators for the studies of materials under irradiation (EMIR) provides access to academic and industrial researchers from the national and international community, to "state of the art" irradiation facilities and online characterizations. About 10 accelerators covering a wide range of particles (ions, electrons and neutrons) and energy, spread over 5 sites (Caen/CIPAC Orleans/CEMHTI, Orsay/CSNSM Palaiseau/LSI, Saclay/SRMA, Saclay/SRMP) are accessible by call for proposals.

These facilities offer various types of online characterization (Raman, RBS, XRD, IR spectroscopy, TEM...). EMIR provides the networking of accelerators, the monitoring of their evolution to better meet the needs of researchers and research programs, the organization of proposal calls and finally the scientific animation including training on radiation effects on materials.

The most concerned scientific domains are primarily the nuclear installation safety with the aging of structural materials including nuclear fuel and waste management, as well as microelectronics, earth sciences, and mastering defects in the solid state physics studies.

EMIR is the only infrastructure at national or international level to offer this irradiation panel.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Over half of the experiments aim to better understand the aging of nuclear materials under irradiation. These researches cover all the chain value from the fundamental aspects to technological measurements. Thus, the EMIR network is in relation with the nuclear industry players (EDF, ORANO, CEA...), and it participates in their economic development and the safety of the facilities. To a lesser extent, ion beam nanostructuring may have some socio-economic impacts.

DATA

Estimated volume stored in 2017: 1 To

Estimated volume stored in 5 years: 5 To

Data access: restricted

Restrictions: the most sensitive data are the experimental proposals of external experimenters in which they reveal part of their project. They must therefore be kept confidential.

Full cost

0.9 M€ in 2016

Personnel

6.5 FTE in 2016



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Caen

Other sites: Orsay, Orléans, Palaiseau, Saclay

French supporting institution: CNRS, CEA

Director: Serge Bouffard

Construction: Operation:

2014

2014

Stakeholders in France: ENSI Caen, École polytechnique – X, Université de Caen Normandie, Université Paris-Saclay

Contact in France:

serge.bouffard@ensicaen.fr

emir.in2p3.fr

High field FT-ICR mass spectrometry national network



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Orsay

Other sites: Paris, Palaiseau, Metz, Villeneuve-d'Ascq, Mont-Saint-Aignan

French supporting institution: CNRS

Director: Guillaume van der Rest

Construction: Operation:

2010

2010

Stakeholders in France: École polytechnique – X, INSA Rouen, Université de Lorraine, Université de Rouen Normandie, Université de Lille, Université Paris-Sud, Sorbonne Université

Contact in France:

guillaume.van-der-rest@u-psud.fr

www.fticr.org

The national network of very high field FT-ICR mass spectrometers is structured as a research federation encompassing seven expert national laboratories. Its aim is to offer a delocalized hosting structure that provides to the scientific community access to instrumentation offering ultra-high resolution and mass accuracy (30% of the experimental time), as well as expertise in the field. Its instruments (with 7 to 12T magnetic fields) are maintained at the highest level and combine technical know-how and methodology to offer unique instrumental configurations to potential users. The scientific groups within the network cover fields in health sciences and biology, heritage materials, analytical and synthesis chemistry and environmental sciences. FT-ICR mass spectrometry is a technique allowing ultra-high performance mass measurement and allows discerning ions with very close masses. It thus provides essential information for the identification of molecular species by their exact chemical formulas, even from complex mixtures and at high masses. Coupled with various ion sources and separation techniques, it allows analysis of almost any type of sample: liquid, solid or gaseous. Coupled with other techniques (trapped ion spectroscopy, ion mobility) it allows molecular species characterization beyond mass measurement (resolving isomers or conformers). Some sites are shared with other infrastructures (IBiSa, MetaboHUB) and the synergy between the IR-RMN THC, IR RENARD (EPR) and the FT-ICR network can cover a range of analytical needs.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The laboratories hosting nodes of the network have many interactions with industrial actors, both with major companies, in particular in the sectors of energy and environment, and local actors (biotechs, environment, cultural heritage). Except in rare cases of work designed for publication, access rules lead towards the development of these partnerships directly between the hosting teams and the industrial partners. The network major role is to offer improved exposure to the sites.

DATA

Estimated volume stored in 2017: 260 To

Estimated volume stored in 5 years: 5,000 To

Data access: restricted

Restrictions: currently access to the data is restricted to the groups producing data and to the staff of the hosting site, as defined in the "intellectual property" section of the network internal rules.

Full cost

0.7 M€ in 2016

Personnel

4.8 FTE in 2016

International dimension

EU_FT-ICR_MS

Coordinator: Christian Rolando

Coordinating country: France

Partner countries: DE, BE, FI, IT, PT, CZ, UK, RU

Website: www.eu-fticr.eu

National high magnetic field laboratory

The National High Magnetic Field Laboratory (LNCMI) is a user facility that hosts scientists from all over the world for doing experiments in high magnetic fields. It is the largest European high field facility and the second largest worldwide, after the NHMFL (USA). In Grenoble, the LNCMI offers static fields up to 36T and in Toulouse, pulsed fields up to 91T in a non-destructive manner and up to 180 T in a semi-destructive manner.

The LNCMI ensures the development of electrical and hydraulic systems, magnets and scientific instrumentation for physical measurements in high magnetic fields. It gives access to high field facilities to users via calls for projects, and supports the implementation, interpretation and valorization of experiences.

Many experiences of physical measurements under high fields are available (spectroscopy UV-VIS-NIR-THz, NMR, EPR, magnetization, transport...). The principal user communities are those of high Tc superconductors, semiconductors, nano-systems and magnetism.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Contracts with companies working on magneto-forming, water treatment, superconducting cables, high power/high voltage electro-mechanical components.

DATA

Estimated volume stored in 2017: 10 To

Estimated volume stored in 5 years: 25 To

Data access: restricted

Restrictions: for the moment, no access for 3rd parties, only for the laboratory staff and the external user team that has generated the data

Full cost

12.2 M€ in 2016

Personnel

88.7 FTE in 2016

International dimension

EMFL

Coordinator: Jochen Wosnitza

Partner countries: FR, DE, NL, UK

Website: www.emfl.eu



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Grenoble

Other sites: Toulouse

French supporting institution: CNRS

Director: Geert Rikken

Construction: **Operation:**

2015

2015

Contact in France:

geert.rikken@lncmi.cnrs.fr

www.lncmi.cnrs.fr

Transmission Electron Microscopy and Atom Probe



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Orsay

French supporting institution: CNRS, CEA

Director: Mathieu Kociak

Construction: Operation:

2009

2009

Contact in France:
mathieu.kociak@u-psud.fr

www.metsa.fr

METSA is a national network of 8 regional platforms that provides the French scientific community unique instruments in the field of Transmission Electron Microscopy and Atomic probe. 8 platforms are: IRMA: GPM, and CRISMAT Rouen, Caen; CEMES, Toulouse; IM2NP and CINAM, Marseille; CLYM, Lyon; PFNC-Minatec CEA-Grenoble; IPCMS, Strasbourg; MPQ, Paris; LPS, Orsay. This network includes in 2016, 13 TEM (field emission, corrected, analytical/spectroscopic, in situ, holographic, 3D), 6 associated FIB/SEM and 3 Atomic Probes (tomographic and analytical).

The missions of the federation are the welcome of scientists through the 2 annual calls for projects, the research in instrumental and methodological developments and in modelling to guarantee a high-level experimental park, the training (by its participation in training courses or workshops), and the advice for implantation of new TEM or AP to favor any effort of pooling, development and the complementarity from the existing environment.

The most represented scientific themes are associated to the skills of platforms and concern the Physics of Materials in the broad sense: nanotechnologies/nanosciences, chemistry of materials, engineering of materials and materials for the health.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Some of the experiments performed in the frame of METSA concern advanced research and innovation projects developed in academic labs (thesis, ANR projects, relations with private companies) and at an R&D level in industries.

DATA

Estimated volume stored in 2017: 50 To

Estimated volume stored in 5 years: 1,000 To

Data access: full

Full cost

0.8 M€ in 2016

Personnel

7.6 FTE in 2016

PETAL



PETawatt Aquitaine Laser

PETAL is a high energy and high power laser, within the LMJ facility. It is a world-class infrastructure for the scientific community working on High Energy Densities (HDE). The first experience campaign lead by an international team took place in 2017. PETAL generates a kJ laser beam and a 0.5-10 picosecond duration pulse coupled with the high energy beams of the LMJ.

The objectives of PETAL are:

1. to obtain in laboratory states of matter under extreme conditions representative of the cores of planets or stars. These extreme conditions are obtained by compression using the laser beams of the LMJ, and by isochoric heating (fast energy deposit) by means of PETAL;
2. the study of Inertial Confinement Fusion (ICF), in particular the keys physical phenomena of "fast ignition" scheme, and the study of "shock ignition" scheme, by creating ultra-short "irradiation" to radiograph targets compressed by the LMJ;
3. the study of astrophysical phenomena simulated in laboratory, such as hydrodynamic instabilities during supernovæ explosions, generation of intense magnetic fields and astrophysical jets, "opacities" of matter, in order to increase our knowledge of the Universe;
4. particles physics and nuclear physics, with the generation of high-energy proton beams, to probe plasma, or for the study of proton-therapy; nuclear reactions in plasma, nucleosynthesis, and nuclei activation. The objectives are detailed in "LMJ-PETAL Scientific Case".

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The development of the necessary technologies for PETAL and the first diagnostics of the EquipEx "PETAL+" (University of Bordeaux) gave rise to scientific collaborations of the CEA with national and international laboratories. The CEA relied upon many industrial companies; most of them are members of the Pole of Competitiveness "Route des Lasers et des Hyperfréquences". The main innovations concerned the optical components and their processing, the laser front end and the compressor.

DATA

Estimated volume stored in 2017: 10 Go

Estimated volume stored in 5 years: 250 Go

Data access: restricted

Restrictions: the data generated by the experiments are preserved by the CEA in the infrastructure. They are provided to applicants for experiments exclusively.



Category: RI

Type of infrastructure: Single site

Infrastructure location: Le Barp

French supporting institution: CEA

Director: Jean-Pierre Giannini

Stakeholders in France: Région Nouvelle-Aquitaine

Construction: Operation:

2005

2017

Contact in France:
userLMJ@cea.fr

www-lmj.cea.fr/en/ForUsers.htm

High-field nuclear magnetic resonance research infrastructure



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Orléans

Other sites: Gif-sur-Yvette, Lille, Bordeaux, Paris, Lyon, Grenoble

French supporting institution: CNRS

Director: Jean-Pierre Simorre

Construction: Operation:

2007

2008

Stakeholders in France: CEA, INSERM, ENS de Lyon, ENS ULM, IPB, Université de Bordeaux, Université Claude Bernard – Lyon 1, UGA, Université Lille – Sciences technologies, Sorbonne Université

Contact in France:
jean-pierre.simorre@ibs.fr

www.ir-rmn.fr

The HF-NMR infrastructure groups together 7 world-class NMR centers equipped with the highest field NMR spectrometers at the national level (11 instruments from 750 to 1,000 MHz proton frequency), into a single entry point integrated infrastructure.

The infrastructure provides to the French scientific community a combination of unique, cutting-edge instrumentation and top level expertise in NMR, together with the associated human resources for a wide variety of advanced experiments in many fields of application, in biology, chemistry, physics, medicine... The centers, distributed throughout the territory, give access to 30% of the available machine time on their instruments. Thus, the infrastructure federates and boosts the national research in NMR. The infrastructure has a coordinated investment policy, which allows one to keep the instrumentation at the cutting edge of technology. The exceptional equipment of the infrastructure as well as its unique worldwide operating mode, give the French research a leading position in NMR.

The main projects and challenges to be met in the coming years are the installation of the first national 1.2 GHz in Lille in 2020/2022, stronger interaction with the industrial partners, an opening to new user communities, an improved monitoring of the impacts of its activities, the development of a data management policy and a stronger involvement in European networks.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Relations with industry are encouraged and in a build-up phase, either via scientific collaborations or in the context of service or research contracts. These studies have a clear impact on the competitiveness of French industrial research. Instrumental or methodological developments are made with the manufacturers, which result in the opening of new markets.

DATA

Estimated volume stored in 2017: 300 To

Estimated volume stored in 5 years: 500 To

Data access: restricted

Restrictions: Accessibility is currently restricted to data producers and staff of the host institution, as defined in the section on intellectual property in the rules of procedure of the RI.

Full cost

—
3.4 M€ in 2016

Personnel

—
22.1 FTE in 2016



National interdisciplinary EPR network FR3443

The RENARD federation is a decentralized infrastructure combining 27 EPR spectrometers operating at X, Q and W bands (including 3 Continuous Waves EPR equipped with ENDOR, 6 pulsed EPR, and 4 equipped with imaging, including 1 pulsed gradients) at the forefront of modern technology, over 10 laboratories and 5 cities.

In addition to making these instruments available to the scientific community, through calls for proposals, as well as an expertise in EPR, Renard's mission is to support existing and future platforms in terms of operating and personnel and to optimize accessibility to a wider scientific community. The role of the federation is also to organize and plan the development of these platforms by ensuring the presence in France of the most advanced equipment in the places where the scientific skills are present.

These platforms constitute places of interdisciplinary exchanges in chemistry, physics, biology, earth sciences at the highest scientific level. They mutualize various and complementary additional techniques and skills provided by different scientific themes.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The infrastructure through in-house research at these sites is developing contractual research with industrial partners on 12 contracts (4 large industrial companies and 8 small and medium-sized companies).

DATA

Estimated volume stored in 2017: 40 To

Estimated volume stored in 5 years: 200 To

Data access: restricted

Restrictions: accessibility is restricted to data producers and host site staff.

Full cost

1.2 M€ in 2016

Personnel

8.8 FTE in 2016



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Lille

Other sites: Marseille, Strasbourg, Grenoble, Paris

French supporting institution: CNRS

Director: Hervé Vezin

Construction: Operation:

2014

2014

Stakeholders in France: CEA, AMU, ENS Chimie de Paris, UGA, Université de Strasbourg, Université de Lille, Université Paris Descartes, Sorbonne Université

Contact in France:

herve.vezin@univ-lille.fr

renard.univ-lille1.fr

National network of large academic nanofabrication centers



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Orsay, Marcoussis, Besançon, Villeneuve-d'Ascq, Toulouse, Grenoble

French supporting institution: CNRS

Director: Michel de Labachellerie

Construction: Operation:

2004

2004

Stakeholders in France: EC Lille, ENSMM Besançon, UFC, UGA, Université fédérale de Toulouse Midi-Pyrénées, UTBM, Université de Valenciennes et du Hainaut-Cambrésis, Université de Lille, Université Paris-Sud

Contact in France:

michel.labachellerie@cncs-dir.fr
isabelle.sagnes@cncs-dir.fr

www.renatech.org

The RENATECH infrastructure is gathering cleanrooms and heavy equipment in micro- & nanotechnology, distributed on the national territory, within five facilities heavily involved in research in micro- & nanotechnology. Together, these facilities represent 7,000 m² of cleanrooms equipped with advanced facilities opened to the scientific community, and bring a global scientific expertise from material elaboration to smart systems. The addressed scientific areas are microelectronics, photonics, MEMS and acoustics, micro-nanotechnologies for biosciences, characterization and instrumentation.

The 5 facilities are belonging to the following laboratories: the Institute of Electronics, Microelectronics and Nanotechnologies (IEMN) in Lille; the Center for Nanosciences et Nanotechnologies (C2N) in Orsay and Marcoussis; the FEMTO-ST Institute (Franche-Comté Thermal Mechanical Electronics and Optics-Science et Technology) in Besançon; the laboratory of microelectronic technologies (LTM) in Grenoble; the Laboratory for Analysis and Architecture of Systems (LAAS) in Toulouse. The mission of this network is to provide to all national laboratories an open-access to these resources, enabling design and manufacture of micro-nano-objects, micro-nanosystems and their integration. The contribution of the infrastructure extends from fundamental to technological sectors.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Many research projects carried out by public laboratories in Renatech cleanrooms are done in cooperation with companies. In addition, our cleanrooms are also open to users working for companies or startups from public laboratories, who have direct access to the equipment and micro- or nanofabrication know-how of these cleanrooms for their exploratory research projects.

DATA

Estimated volume stored in 2017: 1 To

Estimated volume stored in 5 years: 50 To

Embargo period: 60 months

Data access: restricted

Restrictions: RENATECH has set up a confidentiality policy for all information and data relating to collaboration when the partner – particularly industrial partner – requests it.

Full cost

32.5 M€ in 2016

Personnel

165.4 FTE in 2016

International dimension

EuroNanoLab

Coordinator: Michel de Labachellerie

Coordinating country: France

Partner countries: NL, PT, ES, SE, NO, DE, CZ, DK



MES

2



ASTRONOMY AND ASTROPHYSICS



Astronomy and Astrophysics

Astrophysics is concerned by the history of the universe and of its constituents, since its primordial state dominated by still poorly understood fundamental physical phenomena, then its increasing complexity with the formation and evolution of galaxies, stars and planetary systems, up to the emergence of life. Beyond the classical observation in the optical domain, astronomical observation has gradually expanded to the entire electromagnetic spectrum and is now open to new messengers (gravitational waves, neutrinos). Although space observatories are not treated in the present exercise it is important to stress the close link in this theme between space research and non-space research, ground-based observatories and space observatories providing researchers with complementary data. This research is based on theoretical works and numerical modelling, on laboratory experiments, and it needs tools for data treatment and archiving, instrumental developments, integration and test equipments.

As far as research infrastructures are concerned, the strategy in the domain is based on the brain-storming exercises lead during the science prospective seminars organized every five years by the CNRS-INSU with all the institutional actors and the scientific community in order to elaborate the priorities in the development of the means; it takes into account the European and international strategies on ground and in space, the interfaces with other disciplines and the recommendations of the scientific prospective seminars held regularly by CNES for the space component. The conclusions of the last prospective exercise conducted in 2014 by CNRS-INSU and CNES are natural inputs for the elaboration of the national roadmap. The national prospective is consistent with the European strategies built by the **ERA-NET ASTRONET** (self-funded since 2016), which involves the funding agencies of astronomy and covers all aspects of the discipline, from the study of the Sun and the solar system to that of the whim of the universe, and by the **APPEC Consortium** (self-funded since 2012 and successor of the **ERA-NET ASPERA**) which has elaborated for the astroparticles a European strategy covering the 2017-2026 time-range. The European roadmap **ESFRI** and the **Cosmic Vision program of the European Space Agency (ESA)** also play a structuring role.

The International Organisation ESO (European Southern Observatory) operates on its sites in Chile a set of large ground-based telescopes. It presently manages the optical observatories at **La Silla and Paranal (LSP)**,

the later including the **Very Large Telescope (VLT-VLT/I)**, as well as the European participation in the international radio astronomy observatory **ALMA** working in the millimeter and submillimeter domain. This list will grow by the addition in the visible and near-infrared domain of the **ELT** observatory (**Extremely Large Telescope**), labeled landmark in the ESFRI roadmap and currently under construction. Beside these three international components, ESO also appears via a **national IR INSTRUM-ESO (Instrumentation for ESO's large telescopes)**. These instrumental developments, coordinated at national level, place the national scientific community at the highest level in the European framework through the expertise that they confer on the use of the instruments and the interpretation of their data. Within that perspective the labs and the industry must master technologies at the forefront of the state of the art. Finally they set France in an excellent position in terms of national industrial return in the development of the projects.

More specialized and more accessible in terms of observing time, **two very large research infrastructures in international partnership** complement the ESO observatories and the space telescopes: the **CFHT** in Hawaii in the optical domain (Canada, France, United States) and the **IRAM** near Grenoble in the radio millimeter and submillimeter domain (Germany, France, Spain), which operates an array of antennas on the plateau de Bure (Hautes Alpes) and a radio telescope on the Pico Veleta (Andalusia). The **NOEMA** project, which aims at doubling the number of antennas operated by IRAM on the plateau de Bure, is under way.

Two multilateral research infrastructures are now the pathfinders of two major international observatories projects: in decimetric and metric radio astronomy, the **French participation in the ILT network (International Low Frequency Array Telescope)** and its national extension **Nenufar** on the site of the radio astronomy station in Nançay have been labeled *pathfinders* of the international **SKA (Square Kilometer Array)** which will be installed in Australia and South Africa. SKA is the future of radio astronomy with a very strong impact on the study of the "dark ages" of the universe. In the very high energy domain the **HESS** array (**High Energy Spectroscopic System**) installed in Namibia is a precursor of the **CTA** project (**Cerenkov Telescope Array**) that will be installed in the Canary Islands and in Chile.

HESS is supposed to leave the roadmap as soon as CTA becomes operational.

That set of observation means is complemented by a numerical research infrastructure, **the Strasbourg Centre of astronomical Data (CDS)** dedicated to the dissemination of astronomical data and value-added products. The CDS's mission is to collect, mix, distribute and preserve astronomical information, for the benefit of the international scientific community. CDS plays a major role in the development of the Virtual Observatory (VO) at international (IVOA), European and national levels, and coordinates the European activities.

The community is also a user of the national computing and storage tools such as the computing center of the CNRS-IN2P3 and the GENCI, or international (PRACE) to perform theoretical modelling, numerical simulations and massive data processing: future large projects such as SKA will receive, process and archive very large volumes of data, by several orders of magnitude above what we know today. Lab astrophysics is also a user of other research infrastructures such as the SOLEIL synchrotron.

Astrophysics and high energy physics tend to get closer around questions about the unification of the fundamental interactions and the special role of gravitation, the nature

of dark matter and dark energy which represent the majority of the content of the universe, and the search for a new physics beyond the standard models of cosmology for the universe on a large scale and of the particle physics at the subatomic level.

Researchers coming from those two domains may participate together in the development and/or exploitation of some research infrastructures. HESS and CTA have been already mentioned. The future ESA's observatory EUCLID dedicated to the study of the dark universe could also be mentioned. For this later theme, **the LSST (Large Synoptic Survey Telescope)** under construction in Chile (United States, France, Chile) will carry out a deep temporal survey of the entire visible sky and will cover a wide range of investigations from the dark energy to the objects of the solar system and to the transient optical phenomena.

Finally, observation in astrophysics is now open to new messengers such as gravitational waves and neutrinos. For example about the French-Italian **VIRGO** instrument (detection of gravitational waves) and the LIGO-VIRGO transatlantic cooperation we can mention the observation by ground-based and space astronomical observatories of the counterpart in the electromagnetic domain of events seen by the gravitational wave detectors.

RESEARCH INFRASTRUCTURES ASTRONOMY AND ASTROPHYSICS

CATEGORY	NAME	FULL NAME	ESFRI
IO	ESO	European Southern Observatory	
	ESO ALMA	Atacama Large Millimeter/Submillimeter Array	
VLRI	CFHT	Canada-France-Hawaii Telescope	
VLRI	CTA ¹	Cherenkov Telescope Array	CTA (2008)
VLRI	IRAM	Institute for Millimeter Radio-Astronomy	
RI	CDS	Strasbourg Astronomical Data Centre	
VLRI	EGO-VIRGO ²	Observatoire Européen Gravitationnel –VIRGO/ European Gravitational Observatory - VIRGO	
RI	HESS ³	High Energy Stereoscopic System	
RI	INSTRUM-ESO	Instrumentation for ESO's large telescopes	
RI	LOFAR FR-ILT	International Low Frequency Radio Array Telescope - LOFAR FR	
RI	LSST ⁴	Large Synoptic Survey Telescope	
Project	SKA	Square Kilometre Array	SKA (2006)

¹ RI at the interface with the sector "Nuclear and High-Energy Physics".

² RI at the interface with the sector "Nuclear and High-Energy Physics". RI description can be found in the sector "Nuclear and High-Energy Physics".

³ RI at the interface with the sector "Nuclear and High-Energy Physics".

⁴ RI at the interface with the sector "Nuclear and High-Energy Physics". RI description can be found in the sector "Nuclear and High-Energy Physics".



European Southern Observatory

ESO is the main European intergovernmental organization in the field of ground-based astrophysics; fifteen European countries are member-states and contribute in proportion of their GNP. In 2017 a partnership agreement was signed with Australia, and negotiations with Ireland are on-going. Chile, the host country, is not a member of ESO but benefits from 10% of the observation time.

Scientific programs are quite diverse and encompass most of the astronomy domain, from planetary science to cosmology. Apart from solar physics and the direct exploration of the solar system bodies, all major issues of astronomy are addressed. The ESO observatories are as follows:

- La Silla Observatory (telescope of 3.60 m and NTT);
- Paranal Observatory (4 telescopes of 8.20 m of VLT/VLTI, 4 telescopes of 1.80 m and 2 wide field telescopes);
- millimeter and sub-millimeter wave observatory ALMA with a 37.5% share, together with North America (USA and Canada) for 37.5%, Asia (Japan and Taiwan) for 25%, Chile (host country, no direct contribution), comprising 66 antennas (50 antennas of 12 m in diameter for interferometry, 4 antennas of 12 m for total power observations, and a compact network of 12 antennas of 7 m in diameter);
- E-ELT: telescope project in the near-infrared of 39 m in diameter, part of the ESFRI roadmap. The E-ELT first light is planned for 2024, with a start of scientific exploitation in 2026.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

ESO is the main organization for ground-based astronomy in Europe. It acts to structure the research in this field. It is a major player for high tech developments: opto-mechanics, detectors, lasers, complex systems and instruments, software, with an industrial return closed to 60% of its total budget. High visibility in outreach. Program to support formation of PhD and Post-docs.

DATA

Estimated volume stored in 2017: 32 TB
 Estimated volume stored in 5 years: 1,000 TB
 Embargo period: 12 months
 Data access: full

French contribution

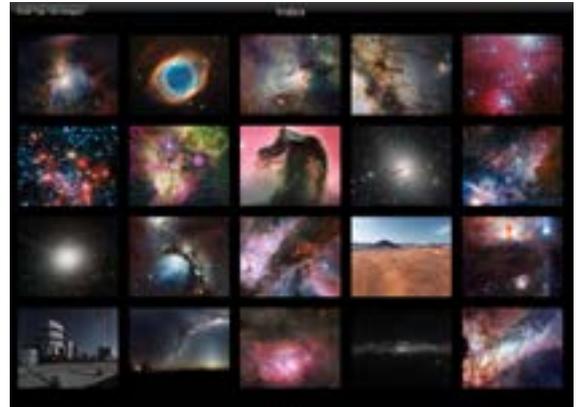
29.9 M€ in 2016

Personnel

687.1 FTE in 2016
 (for the IO)

International dimension

ESO
 Director General: Xavier Barcons
 Partner countries: DE, AT, BE, DK, ES, FI, FR, IT, NL, PL, PT, CZ, UK, SE, CH
 Website: www.eso.org/public/france



Category: IO

Type of infrastructure: Distributed

Infrastructure location: Garching bei München (DE), Santiago (CL), La Silla (CL), Cerro Paranal (CL), Cerro Armazones (CL), Chajnantor plateau (CL)

French supporting institution: MESRI

Infrastructure representatives in France: Laurent Vigroux, Guy Perrin

Construction: **Operation:**

1962

1965

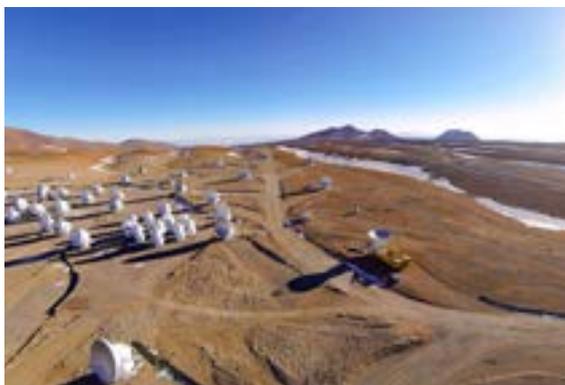
Stakeholders in France: CNRS, CEA, ONERA, Paris Observatory

Contact in France:

laurent.vigroux@recherche.gouv.fr
 guy.perrin@cnrs-dir.fr

www.eso.org/public/france

European Southern Observatory – Atacama Large Millimeter Array



Category: European part of ALMA with an ESO leadership

Type of infrastructure: Distributed

Infrastructure location: Chajnantor Plateau (Chile)

French supporting institution: MESRI

Infrastructure representatives in France:
Laurent Vigroux, Guy Perrin

Construction: Operation:

2003

2013

Contact in France:

laurent.vigroux@recherche.gouv.fr
guy.perrin@cnrs-dir.fr

[www.eso.org/public/france/
about-eso](http://www.eso.org/public/france/about-eso)

The main objectives of ALMA are the study of the molecular gas and dust in the universe. The main scientific topics that can be put forward are the formation and the evolution of galaxies, from the distant universe at high spectral redshift until the local universe, the physics and chemistry of the interstellar medium and the formation of stars and planetary systems, the study of comets and planetary atmospheres, as well as of the small bodies of the solar system.

ALMA is a radio Interferometer comprising 66 antennas (50 antennas of 12 m in diameter for interferometry, 4 antennas of 12 m for total power observations, and a compact network of 12 antennas of 7 m in diameter). The largest available baseline is 14 km to achieve a resolution of 0.007 arcseconds at the highest frequency observed.

Observation time is awarded on calls open to the whole international community. Proposals are evaluated according to their scientific merit by a single time allocation committee; observation time is then assigned so that each partner has a return proportional to its investment, Chile receiving 10%.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

ALMA infrastructure is built by industry: antennas (Thales), Power supplies (Engie), computers (ST-microelectronics) and signal processing. Focal instruments are designed and manufactured in research laboratories, as are the whole software. Many activities in outreach, in particular in Chile. Links with the academic world for training and education. Research in physiology for high altitude labour (5,000 m).

DATA

Estimated volume stored in 2017: 300 To

Estimated volume stored in 5 years: 1,500 To

Embargo period: 12 months

Data access: full

Full cost

—
see ESO

Personnel

—
see ESO

International dimension

ALMA

Director of the Joint ALMA Office (JAO): Sean Dougherty

Coordination countries: Collaboration Agreement North America (NSF), Europe (ESO), East Asia (NINS).

Partner countries: DE, BE, CA, CL, KR, DK, ES, USA, FI, IT, JP, NL, PL, PT, CZ, UK, SE, CH, TW

Website: www.almaobservatory.org, www.eso.org/public/teles-instr/alma

Canada-France-Hawaii Telescope

The CFHT is located in one of the best sites in the Northern hemisphere, which allows sensitive and high quality observations, especially in terms of image quality. All fields in astronomy, including planetology and cosmology, are concerned.

The infrastructure is composed of a 3.6 m telescope and a suite of high performance instruments: MEGACAM (large field imaging in the visible light), WIRCAM (imaging in the infrared), ESPaDOnS (spectro-polarimeter to study the magnetism of stars), Sitelle (a Fourier transform spectrometer in the visible domain) and to come soon (fall 2018) SPIRou (an ultra-stable spectro-polarimeter in the infrared).

The telescope time is distributed following biannual calls for proposals which are evaluated and ranked by a scientific committee. A very large fraction of the telescope time (60%) is devoted to "large programs" with stable instrument configurations, observations made in service mode and very recently real time estimation of the signal to noise ratio in order to optimize the duration of the observations. In the coming years a large fraction of the telescope time should be devoted to two multi-annual major programs:

- the mapping of a large fraction of the northern sky with the MEGACAM camera to study galaxies and to complement the space observations made by ESA's Euclid mission dedicated to the study of dark energy;
- the study of exoplanets around low-mass stars, from spectroscopy observations in the Infrared wavelength domain with the SPIRou instrument.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Innovative instrumentation with cutting-edge technologies is necessary and often requires preliminary R and D. Examples are the Hawaii 4RG detectors for the SPIRou instrument or large gratings for the ESPaDOnS and SPIRou echelle spectrographs.

DATA

Estimated volume stored in 2017: 10 TB

Estimated volume stored in 5 years: 10 TB

Embargo period: 12 months

Data access: full

Full cost

4.2 M€ in 2016

Personnel

42 FTE in 2016
(for the VLRI)

International dimension

CFHT

Director: Doug Simons

Partner countries: FR, CA, USA

Website: www.cfht.hawaii.edu/en



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Hawaii (USA)

French supporting institution: CNRS

Infrastructure representatives in France:

Jérôme Bouvier, Thierry Contini, Hervé Aussel, Guy Perrin

Construction: **Operation:**

1974

1977

Stakeholders in France: Paris DIM-ACAV, Toulouse IDEX, Joseph Fourier University, Aix-Marseille University

Contact in France:

thierry.contini@irap.omp.eu

www.cfht.hawaii.edu/fr

Cherenkov Telescope Array



Category: VLRI

Type of infrastructure: Distributed

Infrastructure location: Paranal (Chile),
La Palma (Spain)

French supporting institution: CNRS, CEA

Infrastructure representative in France:
Jürgen Knödlseder

Construction: Operation:

2016

2020

Stakeholders in France: AMU, École Polytechnique - X, Bordeaux University, Paris Observatory, UGA, University of Montpellier, University of Savoie, Paul Sabatier University - Toulouse 3 -, Paris Diderot University, Sorbonne University, Orsay University – Paris 11

Contact in France:
jorgen.knoedlseder@irap.omp.eu

www.facebook.com/CTA.France

Cherenkov telescopes indirectly detect the high energy gamma-ray photons by measuring the faint flashes of Cherenkov light that is emitted by the cascades of particles created from the interaction of the cosmic gamma-ray photons with the Earth atmosphere. Following the success of the second generation of Cherenkov telescopes for very high energy gamma astronomy (and especially HESS, which mainly results from a French-German collaboration), CTA, with about a hundred Cherenkov ground-based telescopes of three different sizes distributed in two arrays, one in Chile in the southern hemisphere for observing the galactic center and the other in the Canary islands in the northern hemisphere, will be a natural extension of the existing telescopes. CTA will increase the detection sensitivity with respect to the existing infrastructures by more than one order of magnitude while providing a better angular resolution. The different sizes of the telescopes will also allow to cover an extended energy range and to overlap on the low energy side with NASA's Fermi satellite launched in 2008 and operational for 10 years. CTA will thus allow to discover new sources of emission of high energy photons, to better understand the mechanisms of their acceleration and to detect possible signals linked to dark matter.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

CTA creates opportunities for technology transfer. For example, the development of mirrors for the medium-sized telescopes by the CEA/IRFU has led to a technology transfer to the SME Kerdry in the context of a partnership with the Brittany region. The arches of the large-sized telescopes are made in partnership with the SME LORIMA, in the Brittany region.

DATA

Estimated volume stored in 2017: 10 TB

Estimated volume stored in 5 years: 5,000 TB

Embargo period: 12 months

Data access: restricted

Restrictions: during a proprietary period of likely one year the data will only be accessible to the PI of the observation. After the proprietary period the data will become public.

Construction costs (France)

51.8 M€ in € 2016

International dimension

CTA, ESFRI project

Director: Federico Ferrini

Coordinating country: Italy

Partner countries: DE, AU, AT, ES, FR, JP, CZ, UK, SL, CH

Website: www.cta-observatory.org

Institute for Millimeter Radio-Astronomy

IRAM is an international institute (France-Germany-Spain) in charge of developing, operating, and offering to the scientific community two observatories in the millimeter and sub-millimeter wavelength range (0.8 to 3.4 mm, i.e. 70 to 360 GHz). IRAM instruments provide versatile observation possibilities at (sub)millimeter wavelengths, one of the key wavelength range in modern astrophysics. The science topics include in particular the study of the solar system (planetary atmospheres, comets), star and protoplanetary disk formation, late stellar evolution phases, chemical and physical properties of the interstellar medium and nearby galaxies, as well as galaxy formation at high redshift and the related cosmological questions. The two IRAM observatories are:

- a 30-m antenna located on the Pico Veleta, in the Sierra Nevada, near Granada (Andalusia, Spain);
- an interferometer composed in 2018 of 10 15-m antennas with separations of several hundreds of meters, located on the Plateau de Bure, in the Devoluy massif (French Alps); it is currently being upgraded, with the goal to include 12 antennas by 2020 (NOEMA project).

IRAM also hosts dedicated teams and laboratories, covering a wide range of technical and scientific skills: receivers, super-conducting devices, electronics, high-precision mechanics, control software, data reduction software, etc.



Category: VLRI

Type of infrastructure: Distributed

Infrastructure location: Saint-Martin-d'Hères

Other sites: Saint-Étienne-en-Devoluy (FR), Grenade (ES), Pico Veleta (ES)

French supporting institution: CNRS

Director: Karl Schuster

Construction: Operation:

1979

1985

Contact in France:
schuster@iram.fr

www.iram-institute.org

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The NOEMA project has a very strong socio-economic impact, as the major fraction of its budget is used for purchases and contracts with sub-contractors, mostly industries. A number of these contracts include advanced developments with high-tech companies, for instance in the domains of high-precision mechanics or high-speed digital electronics. The estimated number of indirect jobs created by the NOEMA project exceeds 100.

DATA

Estimated volume stored in 2017: 10 TB

Estimated volume stored in 5 years: 1,000 TB

Embargo period: 36 months

Data access: full

Full cost

8.4 M€ in 2016

Personnel

109.9 FTE in 2016
(for VLRI)

International dimension

IRAM

Director: Karl Schuster

Partner countries: FR, DE, ES

Website: www.iram-institute.org

Strasbourg Astronomical Data Centre



Category: RI

Type of infrastructure: Virtual

Infrastructure location: Strasbourg

French supporting institution: CNRS, University of Strasbourg

Director: Mark Allen

Construction: Operation:

1972

1972

Contact in France:

mark.allen@astro.unistra.fr

cdsweb.u-strasbg.fr/index-fr.gml

The mission of the CDS is to collect, standardize, and distribute astronomical information for the benefit of the entire international community. The aim is to facilitate astronomy research by integration of information in its services, with links to the observatory archives, academic journals and other databases, particularly ADS and NED. The CDS is one of the major players in the development of the astronomical Virtual Observatory (VO), which aims at providing transparent access to all astronomy resources online.

The services developed by the CDS are widely used by the community: SIMBAD is the reference database for the identification and bibliography of astronomical objects outside the solar system; VizieR is the reference database for large sky surveys, catalogues and tables published in academic journals, and more and more for other types of data attached to publications; the Aladin interactive sky atlas provides an interactive portal for access to collections of reference images at CDS and images available in the archives of ground and space observatories; CDS also provides a fast cross-identification service for very large catalogues. In 2017, the CDS services managed more than 900,000 queries per day.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Long term contracts to support the open access to the services, including the relevant socio-economic partners of the domain. Contract with the Astronomy & Astrophysics journal for the publication of data associated with the articles. An intern program for universities and engineering schools (about 15 interns per year) serves as an excellent preparation for employment of students in information technology jobs.

DATA

Estimated volume stored in 2017: 1,000 TB

Estimated volume stored in 5 years: 5,000 TB

Embargo period: Until journal publication for the article data (typically 1 month)

Data access: full

Full cost

—
2.8 M€ in 2016

Personnel

—
29.7 FTE in 2016

International dimension

IVOA/Euro-VO International Virtual Observatory of Astronomy

Responsible persons: Giuseppina Fabbiano (President of the IVOA), Vice-President: Mark Allen, Françoise Genova (Representative of the Virtual Observatory France), Mark Allen (Representative of the Euro-VO)

Partner countries: FR, ZA, DE, AR, AU, BR, CA, CL, CN, ES, USA, HU, IN, IT, JP, UK, RU, UA

Website: ivoa.net



HESS

High Energy Stereoscopic System

When entering the Earth atmosphere, gamma rays induce a shower of particles, which, moving faster than light in the air, emit a Cherenkov radiation. This light is detected by an array of ground based telescopes with a large collecting surface, which allows to identify the origin and the energy of each gamma ray. HESS is such an array, deployed over a surface of 15,000 m² in the Namibian desert. The network consists in 4 telescopes of 12 m in diameter each and a 5th very large telescope of 28 m in diameter since September 2012. That one allows to double the sensitivity of the array and to decrease the energy threshold down to 50 GeV, and possibly 20 GeV, in order to extend the type and number of possible sources while improving the overlap with NASA's Fermi satellite: galactic sources (pulsars, centre of the galaxy, supernova remnants), extragalactic objects (active galactic nuclei, gamma-ray bursts) or even exotics sources, such as the galactic halo, globular cluster or dwarf galaxies, that could reveal in gamma rays the annihilations of dark matter particles ("WIMPS"). HESS is devoted to very high energy astrophysics, and concerns in particular the investigation of acceleration and emission mechanisms by galactic and extragalactic sources, and the high resolution mapping in very high energy of the southern sky. HESS could remain operational until the CTA site in the southern hemisphere takes over.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Many companies were involved during the construction phase, involving in particular civil construction, mechanics (metallic structures), electronics, automatism and photon detection.

DATA

Estimated volume stored in 2017: 2,000 TB

Estimated volume stored in 5 years: 5,000 TB

Data access: restricted

Restrictions: Some high-level data products used in publications are available on the project website.

Full cost

—
2.9 M€ in 2016

Personnel

—
17.5 FTE (prorated)

International dimension

HESS

Director: Mathieu de Naurois

Coordinating country: Germany

Partner countries: FR, ZA, AU, AT, IE, JP, NL, UK, SE

Website: www.mpi-hd.mpg.de/hfm/HESS/HESS.shtml



Category: RI

Type of infrastructure: Single site

Infrastructure location: Khomas Highlands (Namibia)

French supporting institution: CNRS

Infrastructure representative in France:
Mathieu de Naurois

Construction: **Operation:**

2002

2003

Stakeholders in France: CEA, AMU, École Polytechnique - X, Bordeaux University, Paris Observatory, Sorbonne University, UGA, Montpellier University, University of Savoie, Paris Diderot University, Orsay Université – Paris 11

Contact in France:
denauroi@llr.in2p3.fr

www.mpi-hd.mpg.de/hfm/HESS/HESS.shtml

Instrumentation for ESO's large telescopes



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Paris

French supporting institution: CNRS

Infrastructure representatives in France:

Guy Perrin

Construction: Operation:

2015

2015

Stakeholders in France: CEA, ONERA, AMU, ENS Lyon, OCA, Paris Observatory, Claude Bernard University- Lyon 1, UGA, Paul Sabatier University – Toulouse 3, University of Nice - Sophia-Antipolis, Paris Diderot University, Sorbonne University

Contact in France:

guy.perrin@cns-dir.fr

The two 2nd- generation VLT instruments that France has led as PI, MUSE (full visible spectrograph dedicated to the study of the formation and the evolution of galaxies) and SPHERE (detection and characterization of extra-solar giant planets by high contrast imaging in the visible and near-infrared) have been successfully integrated at Paranal in 2014 and 2015.

France is today involved in both 2nd-generation VLT-I instruments. France is PI of MATISSE (operating in the mid-infrared for star formation) whose first light occurred in February 2018. France is also the 1st partner of GRAVITY that is dedicated to the study of the Galactic Center with an astrometric accuracy of 10 micro-arcseconds. GRAVITY first light occurred at the end of 2015. Regarding the VLT-I, France is also involved in the development of adaptive optics for the 4 Auxiliary Telescopes (NAOMI project). France is also involved in the realization of MOONS, a wide-field multi-object spectrograph for galactic, extragalactic and cosmological investigations. The preparatory work on the future ELT focuses on adaptive optics and focal instruments. France will have a significant involvement in the first light instruments HARMONI, MICADO and METIS as well as in the Adaptive Optics system (MAORY); French teams have the ambition to lead the construction of the MOSAIC instrument whose phase A review occurred in March 2018.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The industrial return (R et D, co-development, sales) for each built instrument to which France contributes is at least equal to the monetary investment in the RI. For the ELT project, the French teams of the RI together with the industrial partners (groups and SME) have developed a unique know-how mainly in opto-mechanics and detection, for example for adaptive optics systems or spectroscopy; the global industrial return for the ELT is already larger than the French contribution to its funding.

Full cost

6.2 M€ in 2016

Personnel

52.2 FTE in 2016

International dimension

ESO, E-ELT ESFRI Landmark

Director General: Xavier Barcons

Partner countries: DE, AT, BE, DK, ES, FI, FR, IT, NL, PL, PT, CZ, UK, SE, CH

Website: www.eso.org

LOFAR FR-ILT



International LOFAR (Low Frequency Array) Telescope – NenuFAR

LOFAR extends the radio observations to the lowest frequencies and the highest angular resolution accessible from the ground. It is the first truly "digital" radio-telescope, whose operation and performances rely on the transport and high-rate treatment of the signal from thousands of antennas. Its main scientific application fields are cosmology, galaxy clusters, cosmic magnetic fields, cosmic rays, the Sun, the planets and the variable universe (pulsars, black holes and high-energy sources, planets and exoplanets). Each international station includes 96 low-frequency antennas (of 2 dipoles to give full polarization) and 96 high-frequency antenna tiles, connected at high speed (3 Gb/s) to the central correlator in Groningen (Netherlands).

The NenuFAR extension will strongly increase the sensitivity and other characteristics, such as improved calibration; the antennas and the electronics of NenuFAR are optimized for the full 10–80 MHz band. By splitting the signal before it enters the processing electronics NenuFAR will operate simultaneously and independently as both a LOFAR "superstation" (alternative to the existing low-frequency antennas) and as a stand-alone instrument with a specific scientific programming.

DATA

Estimated volume stored in 2017: 6,000 TB
 Estimated volume stored in 5 years: 30,000 TB
 Embargo period: 12 months
 Data access: full

Full cost

—
1.1 M€ in 2016

Personnel

—
23 FTE (prorated)

International dimension

ILT

Director: Rene Vermeulen

Coordinating country: Netherlands

Partner countries: FR, DE, IE, LT, PI, UK, SE

Website: www.lofar.org



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Radio-astronomy Station in Nançay, Cher

French supporting institution: CNRS, Paris Observatory, University of Orléans

Infrastructure representatives in France: Philippe Zarka

Construction: **Operation:**

2011

2011

Stakeholders in France: CNRS, CEA, ONERA, Paris Observatory

Contact in France:

philippe.zarka@obspm.fr

www.obs-nancay.fr/-LOFAR-.html

Square Kilometre Array



Category: Project

Type of infrastructure: Distributed

Infrastructure location: Karoo desert, Republic of South Africa, Boolardy Station, Australia and Jodrell Bank United Kingdom

French supporting institution: CNRS

Infrastructure director in France:
Chiara Ferrari

Construction: Operation:

2020

2025

Stakeholders in France: Bordeaux University, Côte d'Azur Observatory - OCA, Paris Observatory, University of Orléans

Contact in France:
chiara.ferrari@oca.eu

ska-france.oca.eu/fr/accueil-ska

SKA will include two giant telescope arrays located in desert areas of Southern Africa and western Australia covering the centimetric to metric radio bands. At the end of its first phase of deployment, SKA1, with a collecting area of about 0.1 km² and maximum baselines of about 150 km, will allow to go beyond the state of the art of current radio telescopes by more than a factor 10. A major impact is expected for the study of the dark ages of the Universe. Only instrument capable of detecting the distribution of neutral hydrogen that fills the Universe at the time of the formation of the first sources of light, SKA1 will also be able to probe the gaseous content of galaxies up to 9 billion years in the past, to discover the low-frequency gravitational waves inaccessible otherwise and to track the origin of the cosmic magnetic fields. SKA will provide key information, complementary to those from other major observatories, on many fundamental questions of astrophysics and cosmology. On each continent data processing will be performed by two successive HPC infrastructures, a Central Signal Processor on-site, and a Science Data Processor in Cape Town and Perth, producing approximately 500 Petabytes of data each year. Regional Data Centers (Europe, Canada, Africa, India, China and Australia) will provide a mirror archive, the means for data post-processing and scientific analysis, as well as access to data, tools and assistance for future users.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Motivated by the technological challenges of the SKA, 6 French companies have already joined the Maison SKA France, launched by CNRS to federate the national efforts in preparation for the SKA, proposing an innovative financial approach for the large research infrastructures. These companies, expected to increase in number, participate in the preparation of a French contribution to the SKA construction through preliminary studies of energy supply, cryogenics, and architecture for data processing.

DATA

Estimated volume stored in 5 years: 10⁶ TB

Embargo period: 12 months

Data access: full

International dimension

SKA, ESFRI Landmark

Director: Philip Diamond

Coordinator: Inter-Governmental Organization (IGO) – Italy chairs the international negotiations

Partner countries: FR, ZA, DE, AU, CA, CN, IN, ES, IT, JP, MT, NZ, NL, PT, UK, SE, CH

Website: skatelescope.org



NUCLEAR AND HIGH ENERGY PHYSICS



Nuclear and High Energy Physics

Nuclear and high energy physics aim at discovering the ultimate constituents of matter, describing their interactions and understanding their role in the evolution of the Universe and the formation of its constituents. The research in these fields requires large research infrastructures, built and operated by international collaborations during several years and sometimes decades. The strategies for future infrastructures are elaborated at the European level with the participation of CEA and CNRS researchers in specialized strategic committees (particle physics: ESPP, astroparticles physics: APPEC, nuclear physics: NUPPEC).

The detailed study of the Higgs boson properties, discovered at the **LHC** (Nobel prize 2013) as well as the search for new particles and interactions, related for example to dark matter, are the priorities of the discipline. The LHC allows also researchers to use heavy ion collisions, to study the quark gluon plasma constituting the primordial nuclear matter. The update of the European strategy in particle physics in 2020 will provide a long-term vision on possible new infrastructures (ILC, CLIC, HE-LHC, FCC).

The direct observation of gravitational waves (Nobel prize 2017) opens a new window on the Universe and provides further constraints on quantum gravity models, the nuclear equation of state, equation of nuclear matter as well as a better understanding of the nucleosynthesis of heavy elements or a novel measure of the Hubble constant. The current interferometers will progressively increase their sensitivity and be completed by space missions (LISA) and a third novel generation of ground-based interferometers (Einstein Telescope).

With the discovery of neutrino oscillations (Nobel prize 2015) several experiments aim at establishing the mass hierarchy and observing CP violation in the neutrino sector, in order to pinpoint the role of these particles in the description of the primordial Universe. After the T2K experiment in Japan, complementary measurements will be undertaken with the future experiments **DUNE** (US), HyperK (Japan) and **JUNO** (China). In France, the **KM3NeT-ORCA** project, being deployed in the Mediterranean, will provide measurements using atmospheric neutrinos. The KM3NeT-ARCA site, close to Catania in Italy, will be dedicated to neutrino astronomy.

After the discovery of the accelerated expansion of the Universe (Nobel prize 2011), and the spectacular improvement of the knowledge of its composition provided by the space mission Planck space mission, the next major projects in observational cosmology are: the Euclid space mission Euclid and the **LSST** telescope in Chili. The latter one should start operations in 2023 and, thanks to a repeated survey of the sky, also give novel results on transient phenomena in the Universe.

The Pierre Auger Observatory (Argentina) studies cosmic rays at ultra-high energies and, after improving significantly the understanding of their composition, indicates a potential source origin of these cosmic rays. The observation of the Universe at high energy is completed by very high-energy gamma ray gamma-ray astronomy with, in particular the construction of the **CTA** observatory, which will also succeed to **HESS**. in the indirect search for dark matter annihilation signals.

Nuclear physics is interested today in the properties of exotic nuclei and the induced reactions. Several installations are used by scientists, with **SPIRAL2** in France providing soon its first beams. France also contributes to the construction of **FAIR** (Germany), where the first beams should be produced by 2025. The scientific programs of FAIR and SPIRAL2 will benefit from the construction of collaborative detectors (AGATA, FAZIA) which will be used sequentially at the different infrastructures. The discussion about a second phase of SPIRAL2 will start around 2020. The study of the structure of atomic nuclei and their properties under extreme conditions will provide a valuable asset in the comprehension of the Universe, in particular in understanding the origin of elements.

 **RESEARCH INFRASTRUCTURES
NUCLEAR AND HIGH-ENERGY PHYSICS**

CATEGORY	NAME	FULL NAME	ESFRI
IO	CERN	European Organization for Nuclear Research	
VLRI	CERN LHC	European Organization for Nuclear Research Large Hadron Collider	HL-LHC (2016)
VLRI	<i>EGO-VIRGO¹</i>	<i>European Gravitational Observatory - VIRGO</i>	
VLRI	FAIR	Facility for Antiproton and Ion Research	FAIR (2006)
VLRI	GANIL-Spiral2	Grand National Heavy Accelerator (GANIL) – Radioactive Ion Production System in Line of 2nd generation (SPIRAL2)	Spiral2 (2006)
VLRI	<i>CTA²</i>	<i>Cherenkov Telescope Array</i>	<i>CTA (2008)</i>
RI	<i>HESS³</i>	<i>High Energy Stereoscopic System</i>	
RI	DUNE	Deep Underground Neutrino Experiment – Long-Baseline Neutrino Facility	
RI	JUNO	Jiangmen Underground Neutrino Observatory	
RI	KM3NeT	Kilometre Cube Neutrino Telescope	<i>KM3NET (2006, 2016)</i>
RI	<i>LSST⁴</i>	<i>Large Synoptic Survey Telescope</i>	
RI	PAO	Pierre Auger Observatory	

1 RI at the interface with the sector "Astronomy and Astrophysics".

2 RI at the interface with the sector "Astronomy and Astrophysics". RI description can be found in the sector "Astronomy and Astrophysics".

3 RI at the interface with the sector "Astronomy and Astrophysics". RI description can be found in the sector "Astronomy and Astrophysics".

4 RI at the interface with the sector "Astronomy and Astrophysics".



European Organization for Nuclear Research



Category: IO

Type of infrastructure: Single site

Infrastructure location: Geneva, Switzerland

French supporting institution: CNRS, CEA

Representative of the infrastructure in France:
Ursula Bassler

Construction: Operation:

1954

2018

Stakeholders in France: MESRI, MAE

Contact in France:
ursula.bassler@in2p3.fr

home.cern

CERN was created in 1954 under the auspices of UNESCO by an international treaty with France being one of the 12 European founding states. It has now 22 member states, 7 associate member states, and 4 observer states. Major discoveries made at CERN were the neutral currents with the Gargamelle experiment (1971), the W and Z bosons by the UA1 experiment in (1983) and the Higgs boson by the ATLAS and CMS experiments (2012). The "world-wide-web" was also born at CERN (1992). The organization employs today 3300 people and 13500 users worldwide are working regularly at CERN.

The main program is currently the Large Hadron Collider (LHC). It is a unique infrastructure in the world for producing proton-proton or ion-ion interactions at the highest energies ever achieved in the laboratory. This accelerator with a circumference of 27 km is fed by a pre-accelerator complex that has been built and used throughout CERN's existence. Other experiments are also taking place at CERN: at ISOLDE for nuclear physics, at the antiproton decelerator for the study of the effects of antimatter, and on the neutrino platform for the R&D of future experiments in this area. CERN also pursues programs in instrumentation and acceleration techniques. For the needs of its community, it operates computing infrastructures and is preparing to play a key role in the structuring of digital infrastructures and Open Access in Europe.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The financial return for France was estimated in a report from the National Assembly in 2011 and over the last 4 years by CERN between 500 and 550 M€ per year. More than 4000 French companies have responded to calls for tenders issued by CERN since 2011, representing an average of 142 M€/year for materials and service contracts.

DATA

The infrastructure does not store data.

Data access: restricted

Restrictions: restricted to the data policy of the international collaborations

French contribution

148.1 M€ in 2016

Personnel

**3,074 FTE in 2016
(for the IO)**

International dimension

CERN

Director General: Fabiola Gianotti

Coordination countries: France, Switzerland

Partner countries: AT, BE, DE, BU, DK, ES, FI, GR, HU, IL, IT, NO, NL, PL, PT, CZ, RO, UK, SK, SE

Website: home.cern

CERN-LHC



European Organization for Nuclear Research – Large Hadron Collider

CERN is leading particle physics in Europe and operates with the LHC the most important, global infrastructure in the particle physics domain. LHC is currently the particle collider with the highest energies. With the discovery of the Higgs boson, the studies of its properties as well as the search for physics beyond the standard model are the most important scientific goals. A series of upgrades of the accelerator complex will allow increasing the beam intensities to reach higher sensitivities for rare interactions. This phase, called "High-Lumi" -LHC, which will start in 2026, also requires the upgrades of the detectors on which French organisms are involved. The physics of electroweak interactions, of quarks b and c, and thus the study of CP symmetry violation, as well as the plasma quark/gluon are among the challenges that the LHC will face in the coming years.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

French industries are very active at CERN and LHC (62 industrial contracts of more than 1 MCHF for a total amount of 645 MCHF during the construction phase of the LHC).

DATA

Estimated volume stored in 2017: 100,000 To
 Estimated volume stored in 5 years: 500,000 To
 Embargo period: 48 months
 Data access: restricted
 Restrictions: data from each experiment can be accessed by all members of the collaboration. The public dissemination of the data occurs after about 4 years.

French contribution

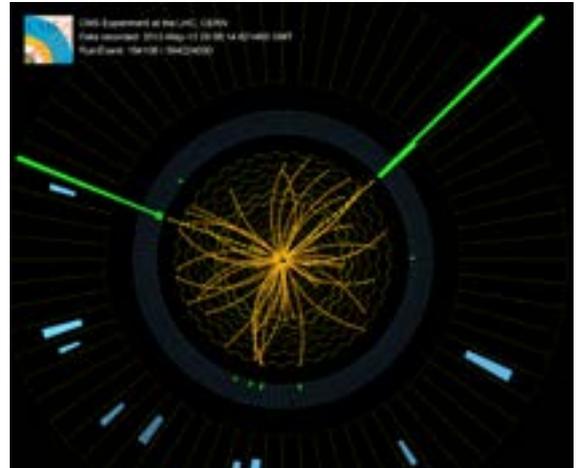
31.7 M€ in 2016
(except CERN IO)

Personnel

210.5 FTE prorated
(except CERN IO)

International dimension

CERN – LHC, ESFRI Landmark
 Coordinators: Karl Jacobs (ATLAS), Federico Antinori (ALICE), Joel Butler (CMS), Giovanni Passaleva (LHCb)
 Partner countries: 38 countries (ATLAS), 47 countries (CMS), 16 countries (LHCb), 37 countries (ALICE)
 Website: atlas.ch, cms.web.cern.ch, lhcb.web.cern.ch/lhcb, aliceinfo.cern.ch



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Meyrin, Switzerland

French supporting institution: CNRS, CEA

Representative of the infrastructure in France:
Patrice Verdier, Anne-Isabelle Etienvre

Construction: Operation:

1994

2018

Stakeholders in France: AMU, Université de Nantes, École polytechnique – X, Grenoble INP, IMT, Université Claude Bernard – Lyon 1, UCA, Université Paris-Sud, Sorbonne Université, Université de Strasbourg, Université Savoie

Contact in France:

patrice.verdier@in2p3.fr
anne-isabelle.etienvre@cea.fr

www.lhc-france.fr

The European Gravitational Observatory – VIRGO



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Cascina, Italy

French supporting institution: CNRS

Representative of the infrastructure in France:
Benoît Mours

Construction: Operation:

2000

2003

Stakeholders in France: OCA, Sorbonne Universités, Université d'Angers, Université Claude Bernard – Lyon 1, Université de Savoie, Université Nice – Sophia-Antipolis, Université Paris Diderot, Université Paris-Sud

Contact in France:
mours@lapp.in2p3.fr

www.ego-gw.it/virgodescription/francese/indice.html

The "European Gravitational Wave Observatory" (EGO) manages the construction and operation of the giant Virgo interferometer dedicated to observe gravitational waves. Expected during cataclysmic events on celestial bodies, these waves slightly bend the space-time, according to the theory of general relativity. The scientific consortium of VIRGO and LIGO (Laser Interferometry Gravitational-Wave Observatory, USA) has jointly detected one of the first emissions of gravitational waves in 2017 using all three interferometers. Following improvements started in 2011, the Advanced Virgo detector is designed to measure tiny variations of distance (10-19 m) between its hanging mirrors suspended in two 3 km long arm, that are induced by the passage of a gravitational wave. The improvements of Advanced Virgo concern the laser, the mirrors, the size of the beam, the system of thermal compensation..., allowing a gain of a factor 10 on the sensibility of the antenna, and thus a factor 1,000 on the volume observable of the Universe. This second generation detector, which will operate nominally mid-2018, will observe the Universe for many months jointly with LIGO at the end of 2018, which will allow the detection of several new sources of gravitational waves (Supernova, coalescence of binary systems of neutron stars and/or black holes). An upgrade phase is considered afterwards.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The construction of the interferometer generates R & D innovations and developments in the field of lasers (specific agreements with Eolite then ALS), thin film deposition, metrology...

DATA

Estimated volume stored in 2017: 1,000 To

Estimated volume stored in 5 years: 5,000 To

Embargo period: 2 months

Data access: restricted

Restrictions: the data used in LIGO-Virgo consortium publications are made public.

Full cost

8.3 M€ in 2016

Personnel

75.1 FTE in 2016

International dimension

EGO-VIRGO

Director: Stavros Katsanevas

Coordinating country: Italy

Partner countries: FR, NL

Website: www.ego-gw.it

Facility for Antiproton and Ion Research

The FAIR project aims at the construction and operation of a new European Facility for Antiproton and Ion Research in Europe on the GSI site (GSI: society for research with heavy ions). This will be an accelerator complex based on the construction of two superconducting synchrotrons with a circumference of 1,100 m, one on top of the other in the same tunnel. These synchrotrons will provide different beams of light and heavy ions. set of different storage rings, production targets and separator spectrometers will provide antiproton beams and secondary radioactive beams. These beams of unmatched quality and intensity are mainly dedicated to nuclear physics research programs (strong interaction, structure of hadrons, plasmas, strong electromagnetic fields...) but also to many other scientific areas (materials science and biology). Scientists are grouped into 4 large collaborations to build the experimental equipment to be used at FAIR: APPA: Atomic, Plasma Physics and Applications (biology, material science...); CBM: Compressed Baryonic Matter; NUSTAR: Nuclear Structure, Astrophysics and Reactions and PANDA: Proton-Anti-Proton Annihilation at Darmstadt. This infrastructure will be complementary to GANIL-SPIRAL2 in France, and ALICE and LHCb at CERN.

DATA

Estimated volume stored in 2017: 0 To
 Estimated volume stored in 5 years: 32 To
 Embargo period: 36 months
 Data access: full

French contribution

33.5 M€ in € 2005

International dimension

FAIR, ESFRI Landmark
 Director: Paolo Giubellino
 Coordinating country: Germany
 Partner countries: FI, FR, IN, PL, RO, UK, RU, SI, SE
 Website: www.fair-center.eu



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Darmstadt, Germany

French supporting institution: CNRS, CEA

Representatives of the infrastructure in France: Fanny Farget, Patricia Roussel-Chomaz

Construction: Operation:

2010

2025

Contact in France:

fanny.farget@in2p3.fr
 patricia.roussel-chomaz@cea.fr

www.fair-center.eu

GANIL-SPIRAL2



Grand National Heavy Accelerator (GANIL) – Radioactive Ion Production System in Line of 2nd generation (SPIRAL2)



Category: VLRI

Type of infrastructure: Single site

Infrastructure location: Caen

French supporting institution: CNRS, CEA

Director: Navin Alahari

Construction: **Operation:**

1975

1983

Contact in France:
navin@ganil.fr

www.ganil-spiral2.eu

GANIL, multidisciplinary research tool for the national and international community, is a fundamental and applied research laboratory in atomic physics, nuclear physics and condensed matter physics. GANIL offers a wide range of accelerated ion beams, using 3 cascaded cyclotrons, from carbon to uranium, in particular for the creation and acceleration of exotic nuclei. GANIL is one of five major laboratories in the world for research with ion beams (GSI- Germany, RIBF/RIKEN-Japan, MSU/NSCL-USA, and FLNR/JINR Dubna - Russia). It is an advanced tool in various fields, including astrophysics and fundamental nuclear physics. Indeed, GANIL allows producing and studying the nuclei that do not exist on Earth: exotic nuclei. SPIRAL 2 is a new infrastructure consisting of a linear accelerator of light and heavy ions and three new rooms: NFS: Neutrons For Science that will deliver a beam of neutrons with energy up to 40MeV, S3: Super Separator Spectrometer designed to exploit the stable beams of very high energies and DESIR: hall for experiments with exotic nuclei at low energies, which will receive the beams from Spiral 1 and S3 and, in the longer term, from a radioactive beams production building.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The SPIRAL2 facility is currently being commissioned and its socio-economic impact was estimated for the construction. From the 92 M€ invested by the end of 2016 39% were spent in the region of Normandy, 50% in France outside Normandy, 8% in other EU countries and 3% outside of EU. The socio-economic impact of the existing facility includes Industrial, Life-Sciences applications and technology transfer.

DATA

Estimated volume stored in 2017: 200 To

Estimated volume stored in 5 years: 1,000 To

Data access: restricted

Restrictions: the access to data can be obtained in agreement with the collaboration who realized the experiment and who is the owner of the data.

Full cost

—
38.9 M€ in 2016

Personnel

—
282.7 FTE in 2016

International dimension

GANIL-SPIRAL2, ESFRI Landmark

Director: Navin ALAHARI

Coordinating country: France

Partner countries: BE, DE, US, IN, IT, PL, CZ, RO, SE

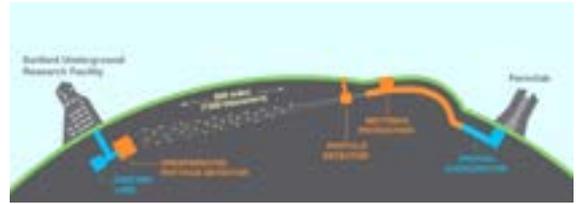
Website: www.ganil-spiral2.eu



DUNE

Deep Underground Neutrino Experiment

DUNE is a research infrastructure dedicated to the study of neutrino properties and proton decay. The experiment is based on a very high intensity neutrino beam produced by a proton accelerator (PIP-II) at Fermilab (Chicago) and detected after 1,300 km by four very large liquid-argon detectors. These detectors of 17 kT each will be operated at 1,500 m in an underground laboratory (SURF, South Dakota). DUNE is under construction and should start data taking by 2024. The infrastructure should be operational for at least 10 years and will perform accurate measurements of neutrino oscillations to determine the neutrino mass hierarchy, to discover a possible CP violation in the leptonic sector, and to perform other precision measurements on neutrino properties. DUNE will also allow the observation of neutrinos from supernova explosions and the search for proton decay. All these measurements aim to explore physics beyond the standard model and to elucidate fundamental problems in cosmology and astrophysics. France could also contribute to the construction of the PIP-II proton accelerator, for which IN2P3 and CEA have recognized expertise.



RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The development of large volume cryostat implied a French company, GTT specialized in LNG tanker equipment. Another key element of the DUNE infrastructure is liquid Argon with Air Liquide as a potential provider. Moreover, French companies could participate in the accelerator construction PIP-II.

DATA

Estimated volume stored in 2017: 1,000 To

Estimated volume stored in 5 years: 10,000 To

Data access: restricted

Restrictions: restricted to the members of the DUNE collaboration, the open access policy is under discussion within the DUNE collaboration.

International dimension

DUNE

Coordinators: Edward Blucher, Stefan Söldner Rembold

Coordinating country: US

Partner countries: BR, BU, CA, CI, CH, CO, KR, ES, US, FI, GR, IN, IR, IT, JP, MG, MX, NL, PE, PL, CZ, RO, UK, RU, SE, CZ, TR, UA

Website: www.dunescience.org

Category: RI

Type of infrastructure: Distributed

Infrastructure location: Dakota, USA

French supporting institution: CNRS, CEA

Representative of the infrastructure in France:

Dario Autiero

Construction: Operation:

2018

2024

Stakeholders in France: Sorbonne Universités, Université Claude Bernard – Lyon 1, Université de Savoie, Université Paris Diderot, Université Paris-Sud

Contact in France:

d.autiero@ipnl.in2p3.fr

www.dunescience.org

Jiangmen Underground Neutrino Observatory



Category: RI

Type of infrastructure: Single site

Infrastructure location: Kaiping, China

French supporting institution: CNRS

Representative of the infrastructure in France:
Jacques Martino

Construction: Operation:

2015

2022

Stakeholders in France: Université de Bordeaux, UniStra, AMU

Contact in France:
jmartino@admin.in2p3.fr

juno.ihep.cas.cn

The discovery of the neutrino oscillation between its different flavors in 2012 opened a breach in the standard model, which had predicted zero mass for this particle. Since this discovery, several experiments have sought to study the oscillation phenomenon as well as the oscillation parameters that govern the questions of mass hierarchy between different neutrino flavors. The Double Chooz experiments in France and Daya Bay in China have brought significant results in the field.

JUNO is a next-generation neutrino detector, which will significantly improve accuracy by using a volume of 20 kilotons of scintillator fluid, read by more than 40,000 photomultiplier detectors. The detector is located in Kaiping City, China, 53 km from the Yangjiang and Taishan nuclear reactors. It is underground, at a depth of about 700 m in order to be protected from cosmic radiations. By detecting neutrino flux, the experiment makes it possible to go back to the parameters of oscillation between the different flavors of the neutrino, with a precision still unequalled.

The experiment aims to study the mass hierarchy, the evaluation of the mixing parameters, on the neutrinos of the reactors, but could also have an impact on the nature of the geo-neutrinos, the neutrinos resulting from the super-nova or solar neutrinos. The detector is designed and built by an international collaboration, which will operate the experiment from 2022.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Developments for electronics that will be taken care by french laboratories will be produced partly in French micro-electronic industries.

DATA

Estimated volume stored in 2017: 0 To

Estimated volume stored in 5 years: 10 To

Embargo period: 60 months

Data access: restricted

Restrictions: restricted to the members of the JUNO collaboration, the open access policy is under discussion within the JUNO collaboration.

International dimension

JUNO

Coordinator: Yifang Wang

Coordinating country: China

Partner countries: BE, DE, CL, US, FI, IT, PK, CZ, RU, SK, TW, TH

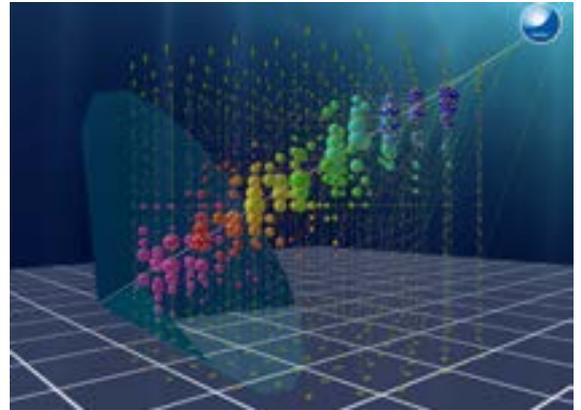
Website: juno.ihep.cas.cn

KM3NET



Kilometer Cube Neutrino Telescope

The Kilometer Cube Neutrino Telescope (KM3NeT) is an European project for a neutrino observatory currently under construction in the Mediterranean Sea. The infrastructure is designed to detect the faint light resulting from the interaction of neutrinos in the seawater. Two sites are being developed: offshore from Toulon, France (Oscillation Research with Cosmics in the Abyss-ORCA) and in Sicily (Astroparticles Research with Cosmics in the Abyss-ARCA) optimized for the detection respectively of atmospheric neutrinos of low energy (3 GeV-100 GeV) and cosmic neutrinos of high energy (1 TeV- 10 PeV). ORCA located 2500 m deep will consist of 115 flexible lines anchored to the seafloor, spaced out by 20 m, carrying detectors (Digital Optical Modules DOM) spaced of 9 m. One of the major goals of KM3NeT-ORCA is the determination of the neutrino mass hierarchy. For KM3NeT-ARCA located at 3,500 m depth, spacing is much larger: 90 m between lines and 36 m between the DOM. This telescope will follow the ANTARES experience with improved sensitivity by an order of magnitude and aims at the discovery and study of astrophysical neutrino sources. These deep-water permanent infrastructures offer important synergic opportunities with earth, sea and environmental science.



RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Within the frame of the development and the deployment of the undersea infrastructure, numerous industrial partnerships have been established: Alcatel, AIM, Comex, CREDAM, Cybernetix, Degreane, ECA, Euroceanique, Foselev Marine, iXSurvey, iXSea, Genisea, Osean, Orange Marine... The development of specific technologies has led to the issue of one patent and the creation of a start-up company, PowerSea for innovative connection systems in the field of marine connectivity.

DATA

Estimated volume stored in 2017: 8 To
Estimated volume stored in 5 years: 1,600 To
Data access: restricted
Restrictions: data access rights for non-members are not yet defined.

Full cost
 —
6.1 M€ in 2016

Personnel
 —
26.7 FTE in 2016

International dimension

KM3NeT, ESFRI Project
Coordinator: Mauro Taiuti
Partner countries: ZA, DE, ES, GE, IT, MA, PL, RU, FR
Website: www.km3net.org

Category: RI

Type of infrastructure: Distributed

Infrastructure location: Toulon, Capo Passero
 Cicily

French supporting institution: CNRS

Representative of the infrastructure in France:
 Paschal Coyle

Construction: Operation:

2014

2018

Stakeholders in France: CNRS, IFREMER, AMU, UTLN, Université de Nantes, Normandie Université, UCA, Université de Strasbourg, Université Paris Diderot, UCBL

Contact in France:
 coyle@cppm.in2p3.fr

km3net.in2p3.fr

Large Synoptic Survey Telescope



Category: RI

Type of infrastructure: Single site

Infrastructure location: Cerro Pachon, Chile

French supporting institution: CNRS

Representative of the infrastructure in France:
Emmanuel Gangler

Construction: Operation:

2009

2022

Stakeholders in France: AMU, Sorbonne Universités, UCA, UGA, Université Claude Bernard – Lyon 1, Université de Montpellier, Université de Savoie, Université Paris Diderot, Université Paris-Sud

Contact in France:
emmanuel.gangler@clermont.in2p3.fr

lsst.in2p3.fr

The Large Synoptic Survey Telescope (LSST) is a large telescope under construction on the Cerro Pachón in Chile since 2014 and will start its observation program in 2022. The main scientific goals of LSST are to study the nature of the Dark Matter and improve the understanding of the Dark Energy. And beyond these and the study of the variable universe, scientists will be able to explore and study with the huge LSST data set, the different structures present in the universe, including our solar system and the Milky Way. With no competitor from the ground, LSST is complementary to the planned large space survey for dark energy study, like the one that will be performed by the Euclid Satellite (ESA project). The compact and unique design of LSST is based on 3 mirrors (8.4 m, 5 m and 3.4 m), leading to a very large extent (320 m² deg²): each LSST panoramic snapshot with its 3,200-megapixel camera will cover an area 40 times the size of the full moon. Its speed combined with the depth and the size of its field of view, will provide to LSST unique observation capabilities. During 10 years of survey, LSST will map the full visible sky twice a week, providing a precise movie of the dynamic universe. Its images will be immediately analyzed to identify objects that have change or moved: from exploding supernovae on the other side of the Universe to asteroids that might impact the Earth.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The scientific and technological challenge represented by the construction and construction of this telescope will lead to innovations in CCD sensors and their reading electronics in France, in the fine optical measurement as well as in databases and data processing in the "Big Data" framework corresponding to LSST.

DATA

Estimated volume stored in 2017: 500 To

Estimated volume stored in 5 years: 10,000 To

Data access: restricted

Restrictions: LSST data rights are restricted to scientists from the USA, Chile, and international partners.

Full cost

—
4.5 M€ in 2016

Personnel

—
23.9 FTE in 2016

International dimension

LSST

Coordinator: David McFarlane

Coordinating country: US

Partner countries: CL, FR

Website: www.lsst.org

Pierre Auger Observatory



The Pierre Auger Observatory brings unique capabilities to study cosmic rays at the highest energies, around and above 10^{18} eV, beyond the reach of terrestrial accelerators. Their study is however a challenge as the cosmic ray flux being too weak ($\sim 1/\text{km}^2/\text{year}$ beyond 10^{19} eV) to allow their direct detection on top of the atmosphere. These cosmic particles are therefore observed through the cascades of secondary particles they generate in the atmosphere, and very large detection arrays should be instrumented to collect a large number of events. The Pierre Auger Observatory covering 3,000 square kilometers in the Argentinean pampa, detect high-energy cosmic rays in an energy range over three orders of magnitude. It combines two techniques to measure the properties of the produced air showers by observing their longitudinal development in the atmosphere through the fluorescence light they produce with 27 fluorescence telescopes, as well as their lateral spread at ground level with the surface detector consisting of 1,660 autonomously operated water-Cherenkov detectors. Both the vast collection area and the hybrid detection strategy led to a large number of valuable results, greatly improving our knowledge of the ultra-energetic cosmic rays. The understanding of the nature and the origin of the highest energy cosmic rays remains an open science case that the Auger collaboration is willing to address with the AugerPrime project.

DATA

Estimated volume stored in 2017: 50 To

Estimated volume stored in 5 years: 100 To

Data access: restricted

Restrictions: the access is restricted to 1% of the existing high-level data.

International dimension

Coordinator: Karl-Heinz Kampert

Coordinating country: Argentina

Partner countries: AU, DE, BR, ES, US, IT, MX, NL, PL, PT, CZ, RO, SI

Website: www.auger.org



Category: RI

Type of infrastructure: Single site

Infrastructure location: Mendoza Province, Argentina

French supporting institution: CNRS

Representative of the infrastructure in France: Corinne Bérat

Construction: **Operation:**

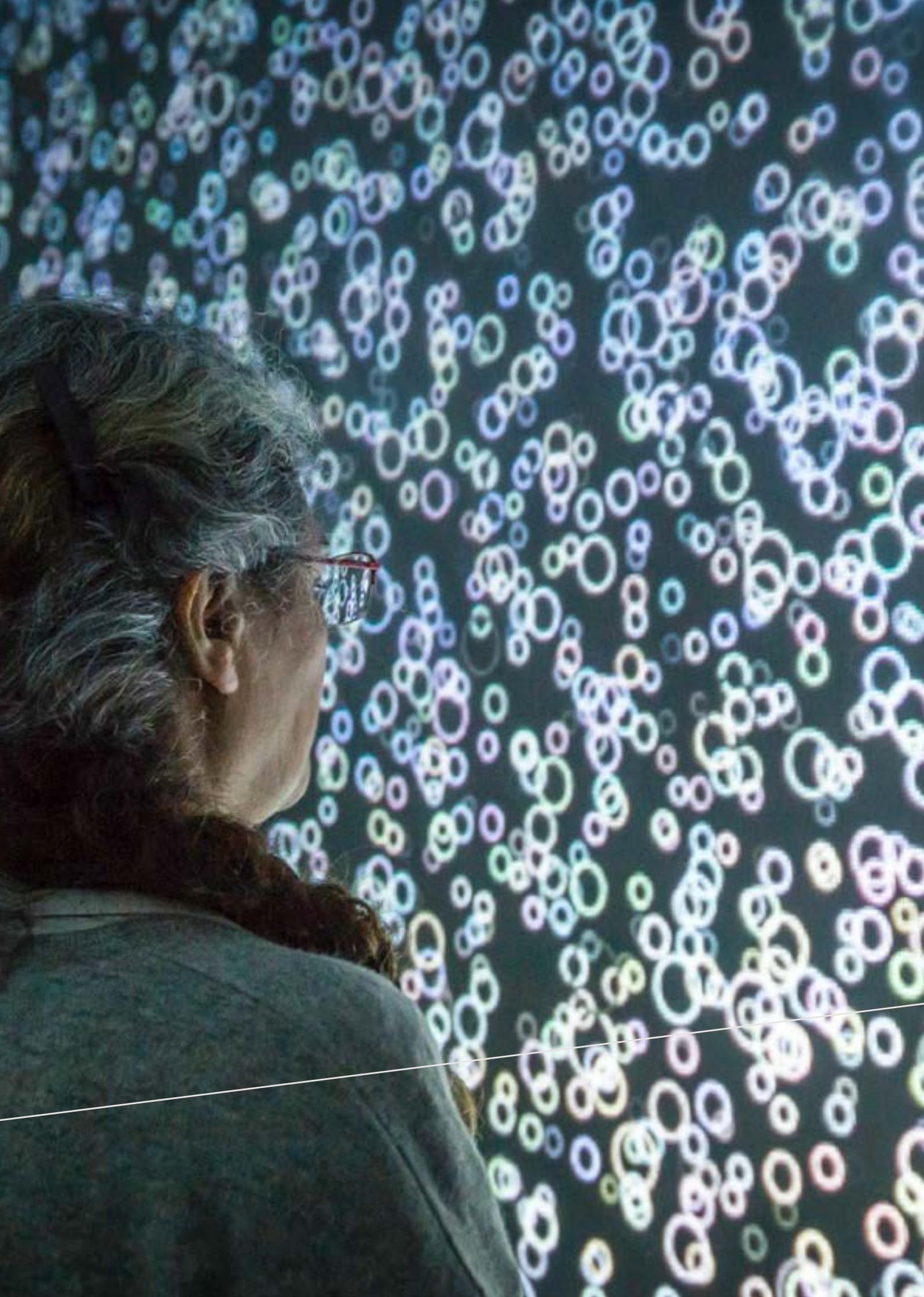
2000

2004

Stakeholders in France: UGA, Université Paris-Sud, Sorbonne Universités

Contact in France:
berat@lpsc.in2p3.fr

auger.cnrs.fr



**RESEARCH INFRASTRUCTURES
IN DIGITAL SCIENCES AND
MATHEMATICS**



Research infrastructures in digital sciences and mathematics

Digital technology is rapidly evolving, with a diverse array of approaches (such as virtual reality, connected devices, sensors), exhibiting exponential growth in functionalities and distribution. As in other sectors, researchers working in digital science fields have pursued collective investment strategies in Research Infrastructures, enabling them to compete at the European and international levels, on a base of the most advanced technologies.

Beyond just monitoring upgrades and strengthening the existing infrastructures, perspectives seeking to develop emerging fields and applications in the near future, should lead to a growing list of digital science infrastructures.

SILECS is a flagship research infrastructure project serving the digital science community. It integrates two previous infrastructures, FIT and Grid5K, which merged to combine resources, capabilities and boost their scientific visibility at both the national and European levels. Already active in areas such as the Internet of Things, virtualization and the associated software layers, SILECS will be able to better develop its heterogeneous and distributed infrastructure, to integrate critical new research themes and skills for the connected distributed systems of tomorrow.

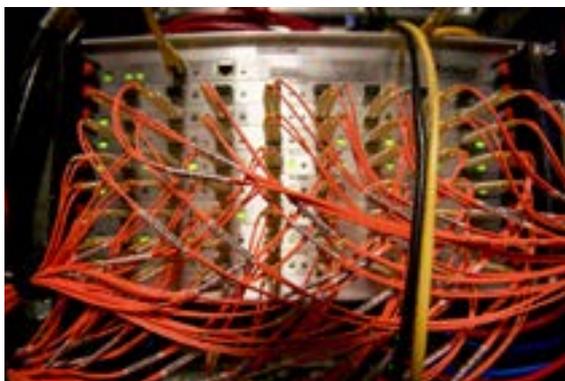
The **TIMES** project supersedes the GERM project, with the goal of strengthening French excellence in fundamental and applied mathematics research, through the development of world-class facilities for scientific meetings and exchanges. This project is centered on 3 poles: the "research and conference centers" pole, linked to the CARMIN labex with IHP-IHES-CIMPA-CIRM, the "industrial relations and society" pole linked to AMIES (national labex) and the MSO network, and finally the "scientific documentation" pole linked with MATHDOC.


**RESEARCH INFRASTRUCTURES
DIGITAL SCIENCES AND MATHEMATICS**

CATEGORY	NAME	FULL NAME	ESFRI
RI	SILECS	Infrastructure for Large-Scale Experimental Computer Science	
Project	TIMES	Transfer and Interfaces: Mathematics, companies and Society	

SILECS

SILECS Infrastructure for Large-scale Experimental Computer Science



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Rocquencourt

Other sites: Grenoble, Lille, Lyon, Nancy, Nantes, Paris, Rennes, Saclay, Sophia-Antipolis, Strasbourg

French supporting institution: INRIA

Directors: Frédéric Desprez, Serge Fdida

Construction: Operation:

2018

2019

Stakeholders in France: CNRS, RENATER, CEA, CDEFI, IMT, CPU, Sorbonne Université

Contact in France:
silecs-dir@inria.fr

www.silecs.net

Digital transformation is made possible by the deployment of a sophisticated distributed service infrastructure, both by its size and the diversity of its components. The platforms that constitute it are complex, heterogeneous, dynamic and of very variable sizes, from connected objects to data centers, connected through various and complementary networks. The result is a system of systems whose availability, reliability and performance are major challenges that academic and industrial players must face to make it an asset of sovereignty, innovation and competitiveness. SILECS is a large-scale scientific tool to extrapolate, observe and validate the models, algorithms and technologies of these large systems. It focuses on four aspects: the Internet of servers, the Internet of things, wireless networks and interconnection networks. It consists of an instrument and software tools that provide a wide variety of advanced computer resources of various sizes. Researchers and engineers from the industry will be able to carry out tests, observations, analyses of models, algorithms and solutions. It unites communities from IT architects to cross-application domains; provides advanced tools to ensure reproducibility and supports an open data approach. Finally, it combines the efforts of the National Research Strategy with the European and International space.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

In addition to its use for academic research, the infrastructure regularly welcomes students for lab work, tutorials or projects. It is also frequently used by companies (who use it, for example, to validate a new solution in a perfectly controlled environment, and on a large scale), either within the framework of collaborative projects, or within the framework of specific contracts of payment by use.

DATA

Estimated volume stored in 2017: 200 To

Estimated volume stored in 5 years: 2,000 To

Data access: restricted

Restrictions: data are produced by user experiments, and are strongly linked to those experiments. Experimenters are responsible for defining their data management plan.

Full cost

—
**1.9/1.9 M€ (FIT/Grid 5000)
in 2016**

Personnel

—
**11.5/9.4 FTE (FIT/Grid 5000)
in 2016**

International dimension

SILECS

Coordinators: Frédéric Desprez, Serge Fdida

Coordinating country: France

Partner countries: GR, CZ, CY, IT, ES

Website: www.silecs.net

Transfer and Interfaces: Mathematics, companies and Society

French mathematics are active on the whole scale from the foundations of research to the interactions with companies and society, up to the highest international level. TIMES is a nationally piloted infrastructure devoted to maintain and develop this excellence through its different missions:

- training in Modeling-Simulation-Optimization (MSO) for innovation in companies and initializing projects with start-ups or SMEs thanks to Amies (Agence pour les mathématiques en interaction avec l'entreprise et la société), the MSO Network and the Interfaces program at CIRM (Centre International de Rencontres Mathématiques);
- hosting, organization and capture of events: scientific semesters, conferences and hosting visitors to high visibility at Cirm, IHP (Institut Henri Poincaré) and IHÉS (Institut des Hautes Études Scientifiques), creation of an audiovisual library, CIMPA (Centre International de Mathématiques Pures et Appliquées) schools;
- development of platforms for management, archiving and open access publishing of scientific documents (audiovisuals, academic journals, media for dissemination actions to society and companies...) via carmin.tv and the Mersenne center of MathDoc (Cellule de coordination documentaire nationale pour les mathématiques).

TIMES is a sustainable research infrastructure at the core and a hub to serve the entire French mathematical community, open to the international community.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

A recent study emphasizes that in France, more than 15% of the GNP and 9% of the employments are directly impacted by mathematics. TIMES is designed to fully develop the innovation potential of mathematics, to make the transfer of mathematical expertise flow better towards the companies and the society (via AMIES, MSO houses, IHP, Cirm). It also aims to magnify the links between the research at the frontiers of knowledge of the French mathematical school, the society and the companies.

DATA

Estimated volume stored in 2017: 40 To

Estimated volume stored in 5 years: 80 To

Full cost

14.9 M€ in 2016
(GERM numbers)

Personnel

71 FTE in 2016
(GERM numbers)



Category: Project

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Marseille, Bures-sur-Yvette, Saint-Martin-d'Hères, Nice

French supporting institution: CNRS

Director: Emmanuel Royer

Construction: **Operation:**

2018

2018

Stakeholders in France: AMU, UCA, UGA, Sorbonne Université

Contact in France:

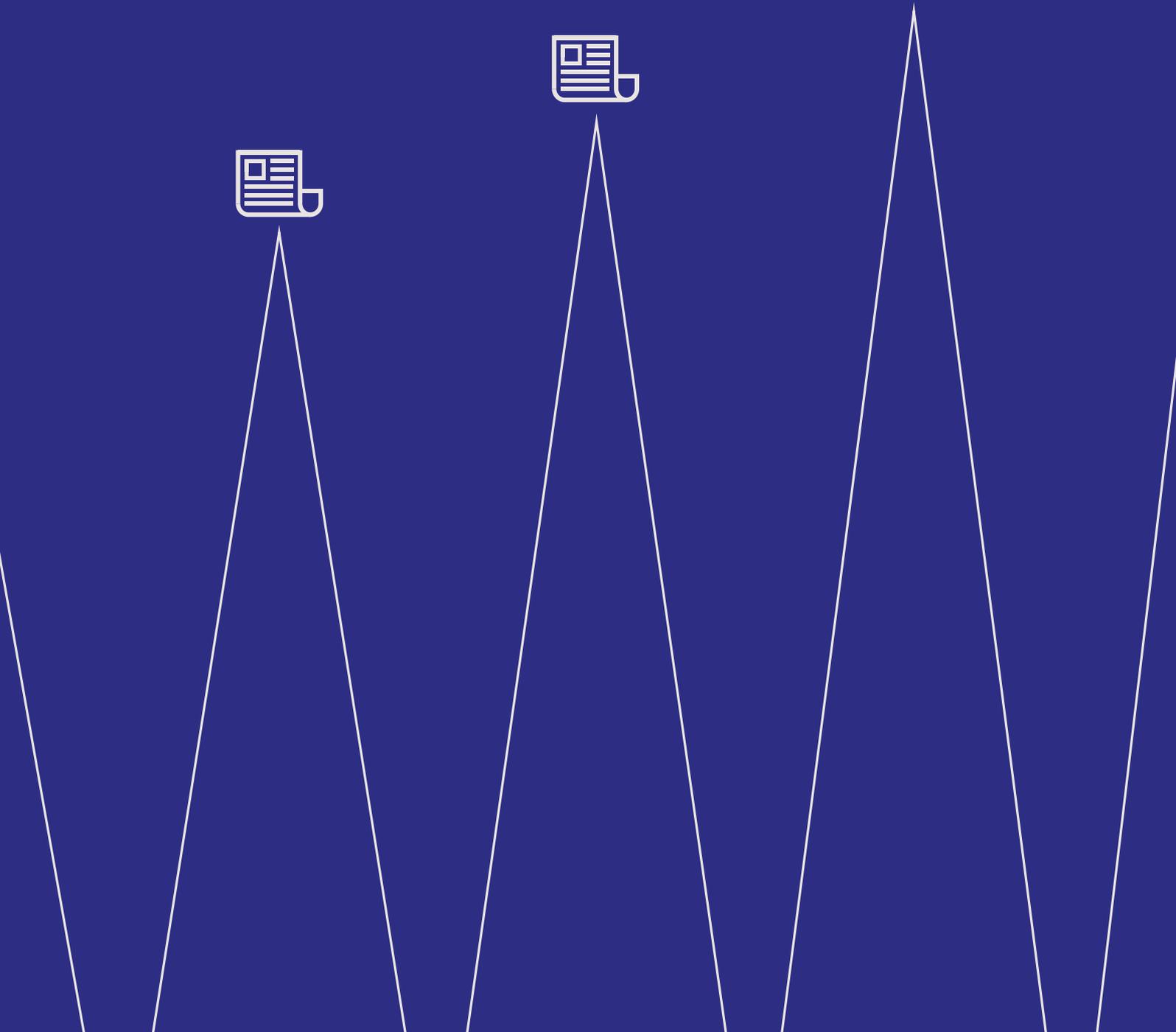
emmanuel.royer@cnrs.fr

www.ihp.fr/fr/institut/IHP/lab-ExCARMIN

www.agence-maths-entreprises.fr



SCIENTIFIC AND TECHNICAL INFORMATION



Scientific and technical information

Scientific and technical information (STI) infrastructures increased in importance during the 2000s. This was due to the accelerated digitization of scientific publications, and the development of international platforms for distributing publications. These facilitated the creation of more efficient scientometric tools. In France, STI is now considered as a field in itself. As such, it is geared with infrastructures that are essential for scientific practice, based on its importance in the economy of research systems. The structuring of a very active but highly scattered sector is a primordial objective, and the development of access to an abundant high-quality scientific resource offering of limited cost is also a key aim.

needs of researchers. Increased in scale, these platforms – HAL, OpenEdition, Numédif (MÉTOPES since 2018), and PERSEE associated with Collex libraries – have been listed as Infrastructures in STI on the 2016 roadmap. This is under the supervision of the Athena Alliance, on behalf of all French scientific Alliances.

The Digital Republic Act enforced in 2016 paved the way to the adoption by France of measures to encourage Open Access to scientific publications. This is in agreement with the worldwide movement of Open Science, which parallels the opening of public data (Open Data). The Committee for Open Science (CoSO) has now taken over from BSN. Under the aegis of this committee the missions of the four platforms are to be consolidated, and reentered in the 2018 roadmap. The aim of this is to accelerate the dissemination of research results by facilitating the deposit for researchers, the work of edition and publication of scientific output, and the development of services for easier access and exploitation.

1 FROM THE DIGITAL SCIENTIFIC LIBRARY TO INFRASTRUCTURES: HAL, OPEN-EDITION, MÉTOPES AND COLLEX-PERSÉE AS SUPPORTS OF OPEN SCIENCE

A national coordination and cooperative structure for STIs, named “Digital scientific library” (*Bibliothèque scientifique numérique: BSN*), was created in 2009 to provide researchers with a world-class STI offer and to improve the visibility of French research. BSN is focused in particular on the subscription to scientific journals, the acquisition of digital archives (“PIA” ISTE program of 60 M€) and on national licenses (Elsevier, etc.). In addition it plays an important role in the development of Open Access. It has supported the development of STI platforms created in response to new

2 THE FOUR PLATFORMS IN STI: HAL, OPENEDITION, MÉTOPES AND COLLEX-PERSÉE

These four platforms are complementary “usage-technology” sets, which cover the whole process of disseminating scientific output. They share the goal of opening French scientific production internationally, while ensuring technological independence. They all interact with international infrastructures (e.g., shared metadata, partnership agreements, and deposit transfer schemes).

DISSEMINATION PROCESS OF RESEARCH OUTPUTS



2-1 The HAL platform: management of preprints and postprints; multiple versions and archiving of the scientific output in Open access

HAL is an Open archive (hal.archives-ouvertes.fr) where to deposit scientific articles, with associated data, as well as theses in Open Access. This repository was created in 2001 by the CNRS, and has been adopted by all French higher education and research institutions. In 2006, research institutions and universities signed a memorandum of understanding agreeing on a coordinated national effort for the open archiving of scientific output. The HAL platform is connected to many international repositories, including ARXIV. To complement this platform, the Centre for Direct Scientific Communication (CCSD), associating the CNRS, INRIA, INRA, and the Université de Lyon, has created other tools: Sciencesconf.org (conferences), Episciences.org (overlay journals), and Héloïse (publisher copyright and dissemination policies).

2-2 The OpenEdition platforms: Open access dissemination of published scholarly output and experimenting with new forms of scientific writing (journals and books in social sciences and humanities, or SSH, with associated tools)

These four platforms host 482 journals, 2,612 research notebooks, 5,392 books, and promote more than 38,000 scientific event announcements (May 2018). OpenEdition draws together international research communities (50 million annual visits).

On a European level, its visibility as an infrastructure increases the impact of the multidisciplinary research projects that it disseminates, and their ability to transfer their results to help business and society to address societal challenges.

All this involves:

- improving the accessibility and dissemination of scientific publications, especially in SSH;
- coordinating digital transition among SSH publishing stakeholders;
- fostering good practices and developing scientific and editorial quality standards;
- developing sustainable and transparent financing methods for Open access publications;
- supporting the emergence of new research methods through digital publication.

2-3 MÉTOPES: multi-channel edition and dissemination

The MÉTOPES platform has been developed by a research unit working for the publishing activities of the University of Caen. This shared public platform complies with norms and standards in the fields of publishing and digital distribution, and also operates a network (for training, partnerships, etc.). It optimizes the editorial production of scientific writings and their provision in a digital form (archives, platforms, etc.).

Special attention is given to the articulation and interoperability with the public STI operators OpenEdition (platforms), Hal (open archives) and Persée (digitization of primary material and prints). MÉTOPES is now compatible with the standards of the OpenEdition Journals and Cairn journal platforms and OpenEdition Books.

2-4 COLLEX-PERSÉE: identification, highlight and consolidation of major scientific collections available online and in major libraries

Established as a scientific interest group, or GIS, the fourth infrastructure coordinates the activities of crucial actors for the benefit of researchers, libraries. It works in interaction with them, as essential stakeholders in the research production process, as well as in the dissemination of scientific output. Under the supervision of academic and research institutions and organizations, the CollEx-Persée GIS brings together the National Library of France, major research libraries, the Persée digital platform, and STI operators (ABES, CTLes, Inist). Its aim is to develop state-of-the-art services linked to scientific collections, in cooperation with researchers, to best meet their constantly renewed needs.

Relying on the Persée digitization platform, this infrastructure makes it possible to manage and highlight major heritage and scientific collections. It is also a major tool for acquisition and shared preservation policies, whose logic is both disciplinary and based on territorial strategies, with the goal of serving all research communities across France.



RESEARCH INFRASTRUCTURES SCIENTIFIC AND TECHNICAL INFORMATION

CATEGORY	NAME	FULL NAME	ESFRI
VLRI	<i>Huma-Num</i> ¹	<i>Very large research infrastructure for digital humanities</i>	<i>DARIAH (2006) CLARIN (2006)</i>
RI	CollEx-Persée	Collections of excellence for Research - Persée	
RI	HAL, CCSD	HAL open archives	
RI	<i>MÉTOPES</i> ²	<i>Methods and tools for structured publications and editions</i>	
RI	<i>OpenEdition</i> ³	<i>Open access to scholarly communication in the humanities and social sciences</i>	
RI	<i>RnMSH</i> ⁴	<i>French Network of Social Sciences and Humanities Centers</i>	

1 RI at the interface with the sector "Social Sciences and Humanities". RI description can be found in the sector "Social Sciences and Humanities".

2 RI at the interface with the sector "Social Sciences and Humanities".

3 RI at the interface with the sector «Social Sciences and Humanities».

4 RI at the interface with the sector "Social Sciences and Humanities". RI description can be found in the sector "Social Sciences and Humanities".

Collections of excellence for Research – Persée

CollEx-Persée is a coordinated network pooling a national digital facility (Persée), large research libraries, including the French national library, and national STI entities (ABES, CTLES, Inist). All these stakeholders are gathered under the umbrella of a scientific interest group, or GIS, together with the CNRS and the Athéna Alliance. Its main purpose is to ease access to, and to foster use of, information resources by research communities. CollEx-Persée focuses on large collections held by research libraries and heritage institutions, whether it is printed documents, digitized corpora, electronic resources, special collections, archives and more generally any type of materials to support research in all disciplines. It is a framework for the development of national policies for digitization and shared preservation and for the implementation of concerted actions.

Four priorities are addressed:

1. improving the visibility of the collections by mapping and referencing them;
2. enriching the information offering through document collection and digitization, and licensing;
3. developing new services with researchers (subject-based expertise, management of datasets, support to Digital Humanities projects, information literacy, open access to research outputs, interlibrary loan, etc.);
4. ensuring long-term preservation of collections. Persée is the key operator for both coordinating the digitization programs with researchers and managing scholarly enhancement and online dissemination of digitized corpora.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

CollEx-Persée provides access services to scientific and technical information for independent workers, VSEs and SMEs that do not have major documentary capabilities (particularly in law, medicine, economics, management, engineering sciences).

DATA

Estimated volume stored in 2017: 119 To

Estimated volume stored in 5 years: 165 To

Data access: full

Full cost

21.8 M€ in 2016

Personnel

123.2 FTE in 2016



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Strasbourg

Other sites: Aubervilliers, Lyon, Bussy-Saint-Georges, Montpellier, Paris, Nanterre, Orsay, Saint-Martin-d'Hères, Vandœuvre-lès-Nancy

French supporting institution: Bibliothèque nationale et universitaire de Strasbourg

Director: Alain Colas

Construction: Operation:

2014

2014

Stakeholders in France: ABES, BnF, Campus Condorcet, CNRS, CTLES, ENS de Lyon, IEP de Paris, MESRI, MNHN, UGA, Université Paris 1 – Panthéon Sorbonne, Université Paris Descartes, Université Paris Nanterre, Université Paris-Sud

Contact in France:
alain.colas@bnu.fr

www.collex.eu

HAL open archives



Category: RI

Type of infrastructure: Virtual

Infrastructure location: Villeurbanne

French supporting institution: CNRS

Director: Christine Berthaud

Construction: Operation:

2000

2001

Stakeholders in France: INRIA, UDL, INRA

Contact in France:

christine.berthaud@ccsd.cnrs.fr

hal.archives-ouvertes.fr

HAL is a multidisciplinary open archive platform used by all researchers and academics affiliated to higher education and public research organizations. HAL is connected to the main international servers like ArXiv, PubMed Central, RePEC, OpenAIRE.

HAL is dedicated to disseminating open access documents produced by research (pre-print or post-print journal articles, conference papers, books, etc.) on 380 disciplines in 13 major scientific fields. Its strategy is part of the international movement of open access and H2020 programme. Submissions are subject to quality data moderation, i.e. technical compliance of file formats, file and metadata coherence, publishers' policies and verification of the scientific nature of the document. It is the common and shared platform for the entire French higher education and research sector as part of an inter-institution agreement (2013).

HAL also provides all the tools and functions to institutions seeking to create and implement their own institutional open archive platform. HAL also provides open archives with technical solutions for deposit transfers. HAL achieves the long-term data preservation with CINES. All reference indexes used in HAL are accessible in an open access website. A triplestore exposes in RDF the data of the archive and its reference indexes. HAL develops interconnections with other national operators and also with similar major international projects.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The platform provides open access to scientific literature for the widest possible dissemination and without financial barrier to science. HAL is an open archive that implements open data and promotes the exploitation of data by public and private entities.

DATA

Estimated volume stored in 2017: 8 To

Estimated volume stored in 5 years: 20 To

Embargo period: 12 months

Data access: full

Full cost

—
0.9 M€ in 2016

Personnel

—
11.6 FTE in 2016

Methods and tools for structured publications and editions

MÉTOPEs is an infrastructure designed for publishers and to serve the editorial activities of all higher education and research institutions. In the current transition context from print (subscription-based) business models to digital open access, it provides methods and tools to enable the creation of structured editorial content repositories and to help scholarly publishers to manage the transformation of the publishing and distribution functions in keeping as closely as possible with their goals and missions of research result and data dissemination. Therefore, its aim is to ensure an optimal circulation and availability of scholarly writings both online (in archives and on platforms) and in print (as books or journals available in bookshops, in libraries or directly to private persons) and to increase the international visibility of French public scientific publishing output.

It is an alerting, development and training technological infrastructure dedicated to those who produce edited data output. It provides them with methods and tools to implement a standard (based on the Text Encoding Initiative vocabulary) to encode published content as standardized, reconfigurable, sustainable digital collections with rich metadata and high interoperability potential. It enables publishers to control the full ownership of their digital collections and thus meet the challenge of achieving reasonable open access publishing in full autonomy.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Joint development and testing procedure agreements with software industry partners for the development of standardized structured workflow environments (XML-TEI; EAD; ONIX; Daisy for accessibility, etc.), and with typesetting and print publishing industry partners for the development of automated typesetting tools for structured editorial workflows to obtain printed books, e-pubs and to feed into digital distribution platforms (OpenEdition, Cairn, Scielo, etc.) or online Print-on-demand services.

DATA

The infrastructure does not store data.

Embargo period: 12 months

Data access: full



Category: RI

Type of infrastructure: Distributed

Infrastructure location: Caen

French supporting institution: Université de Caen-Normandie, MRSH

Director: Dominique Roux

Construction: Operation:

2018

2018

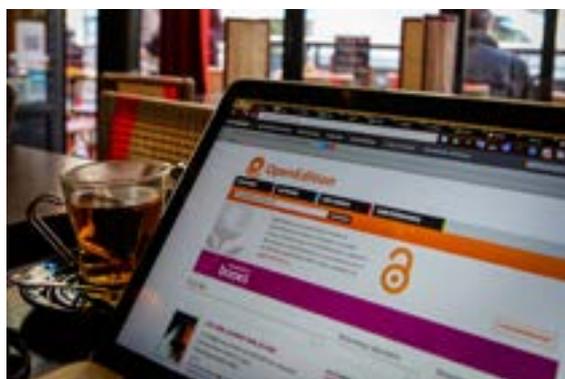
Stakeholders in France: CNRS

Contact in France:

dominique.roux@unicaen.fr

www.metopes.fr

Open access to scholarly communication in the humanities and social sciences



Category: RI

Type of infrastructure: Virtual

Infrastructure location: Marseille

Other sites: Paris, Villeurbanne

French supporting institution: CNRS, AMU, EHESS, Université d'Avignon et des Pays de Vaucluse

Director: Marin Dacos

Construction: **Operation:**

2007

2007

Contact in France:

marin.dacos@openedition.org

www.openedition.org

OpenEdition is a comprehensive infrastructure for electronic publishing in the humanities and social sciences, created and operated by OpenEdition Center. It brings together complementary platforms dedicated to journals (OpenEdition Journals), books series (OpenEdition Books), research blogs (Hypotheses) and academic announcements (Calenda). In 2017, OpenEdition received more than 4 million visits per month from all around the world.

OpenEdition's mission is to encourage the development of high-level electronic publishing on an international scale. OpenEdition was born from a very simple idea: the various actors in academic publishing were being drowned out by the vast ocean of the web and their efforts were being dispersed. Grouped around a central federating platform (OpenEdition) and specialized platforms (OpenEdition Journals, OpenEdition Books, Calenda, Hypotheses), other economies of scale are possible. A critical mass of content, technologies and skills means our role is not limited to publishing academic documents online, but also to offering training in new publishing practices, to reaching out internationally, to developing a sustainable economic model and to implementing regular technological innovations.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

OpenEdition Freemium is a programme for the development of open access academic publishing in the humanities and social sciences. This partnership, on offer exclusively to institutions (libraries, campuses, research institutes), aims at creating an innovative and sustainable economic model. All income generated by the programme is reinvested in the development of open access academic publishing, and 2/3 are paid to the publishers.

DATA

Estimated volume stored in 2017: 6 To

Estimated volume stored in 5 years: 10 To

Data access: restricted

Restrictions: Mainly open access. Data access depends on publication policies. 80% of books are open, no embargo on the other 20%. 75% of journals are open, the embargo for the other 25% varies from 6 to 24 months.

Full cost

—
2.9 M€ in 2016

Personnel

—
39.9 FTE in 2016

International dimension

OPERAS

Director: Marin Dacos

Coordinating country: France

Partner countries: DE, HR, GR, IT, NL, PT

Website: operas.hypotheses.org



E-INFRASTRUCTURES



E-Infrastructures

The need for storage capacity, processing (in the broadest sense), and the exchange of large data volumes is rapidly expanding in most sectors, underlining the crucial importance of a national strategy integrating the necessary rationalization and mutualisation steps, to enable the digital infrastructures servicing research communities to be strengthened, while controlling the costs as best as possible.

Most digital infrastructures serving the scientific communities are platforms organized in networks. These recently built infrastructures aim to coordinate actions at the national level in sync with activities at the European level.

Digital service infrastructures are typically open to several, if not all, French research communities. This is the case for **Renater** and **GENCI**, which are French components of larger European infrastructures, GEANT and PRACE respectively (Landmark ESFRI), that promote research excellence.

Given the diffuse nature of digital sciences and technologies, infrastructures in other major sectors – such as at the interfaces of Biology and Health, or Human and Social Sciences – also contribute to providing access to digital infrastructures and services for targeted communities.

RENATER's network infrastructure provides secure, high-speed digital communication to all Higher Education and Research Institutions and communities in France, as well

as linking to global networks. As well as its core technical service, it also played a leading role in developing, proposing and implementing IT services, such as videoconferencing, file exchange for large files, and access management, which enables researchers in France, as in Europe, to use secure identification services.

For 10 years, the GENCI infrastructure has been providing high-performance computing facilities (supercomputers) at three national centers for the CNRS, the CEA and universities: the IDRIS, the TGCC and the CINES, respectively. In the light of its updated mission to store data, GENCI is also now fully entering the Big Data world. GENCI has just upgraded the calculation resources of the TGCC, which will be opened up to the European PRACE collaboration, extending the French commitment to this project, and in preparation for the French commitments to the planned EuroHPC structure.

In addition to these large digital production infrastructures, **CC-IN2P3** and **France-Grilles** provide distributed computing services and large volume data hosting. CC-IN2P3 specializes in massive data storage, and in processing data for the LHC, but is also open to other large research instruments and infrastructures, such as the LSST telescope. France-Grilles develops services facilitating access to distributed computing for hundreds of users from diverse communities, and participates in the European EGI project, a key player in the *European Open Science Cloud* (EOSC) project.


**RESEARCH INFRASTRUCTURES
E-INFRASTRUCTURES**

CATEGORY	NAME	FULL NAME	ESFRI
VLRI	GENCI	Grand Équipement National de Calcul Intensif	PRACE (2006)
VLRI	RENATER	National Telecommunications network for Technology, Education and Research	
RI	CCIN2P3	IN2P3/CNRS Computing Center	
RI	France Grilles	France Grilles	

Grand Equipement National de Calcul Intensif



Category: VLRI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Bruyères-le-Châtel, Orsay, Montpellier

French supporting institution: MESRI

Head of the infrastructure:
Philippe Lavocat

Construction: Operation:

2007

2007

Stakeholders in France: CNRS, CEA, CPU, INRIA

Contact in France:
contact@genci.fr

www.genci.fr

GENCI provides French academic and industrial scientists with the best supercomputers to carry out cutting-edge work requiring the use of numerical simulation. GENCI main missions are:

- to provide intensive computing hours regarding the needs of the national research community;
- to implement the French national strategy for equipping in HPC et storage resources the 3 national computing centers: TGCC at CEA, IDRIS at CNRS and CINES for the French Universities. GENCI is in charge of the multi-year investment plan taking into account the evolution of its supercomputers operated in the 3 centers;
- to promote the use of numerical simulation and HPC. GENCI leads or participates in various digital simulation dissemination projects: Equip@meso project and the HPC for SMEs Initiative;
- to participate in the realization of an integrated European HPC ecosystem. GENCI represents France as a hosting member (with GCS-Germany, CINECA-Italy, BSC-Spain, PizDaint-Switzerland) in the European PRACE infrastructure which provides European users with world-class systems and high-valued services (training, code enabling, support for SMEs...).

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

The GENCI computing resources are open to industrial users for open R et D. 15% of the 600 annual research projects supported by GENCI have an industrial partner. Carried out by GENCI et Teratec, the SiMSEO project help SMEs for using the capacities of simulation.

In 2017, GENCI commissioned an impact study conducted with econometric methods and independently by the Vertigolab laboratory.

An expend of 1€ from GENCI generated 1.93€ of production and 0.87 of value added in the French economy.

DATA

Estimated volume stored in 2017: 60,000 To

Estimated volume stored in 5 years: 120,000 To

Data access: restricted

Restrictions: Only accessible to researchers who have produced this data on supercomputers.

Full cost

48.4 M€ in 2016

Personnel

84.3 FTE in 2016

International dimension

PRACE AISBL, ESFRI Landmark

Director: Serge Bogaerts

Coordination countries: DE, ES, IT, FR, CH

Partner countries: DE, BE, BU, CY, DK, ES, FI, GR, HU, IE, IS, IT, LU, NO, NL, PL, CZ, UK, SK, SI, SE, CH, TR

Website: www.prace-ri.eu

RENATER

National Telecommunications network for Technology, Education and Research

To support the whole scientific, technology and education community, RENATER implements a national backbone of communication (13,000 km dark optical fibers), equipment of generating signals, switching and super and hyper vision. The missions of RENATER are:

- to provide stakeholders/partners in research and education community the medium of high-speed digital communication and data management associated to France (Metropolitan, in "overseas community and region") on the base of network, infrastructure and services;
- ensure that all those mediums are secured;
- ensure global interconnection of research and education network;
- ensure the team work in the network and to meet the advances and innovative needs of research and education community;
- ensure consultancy assignment, expertise, to provide mediums of communication or the services in the domains of competence to the nearby state and other French and foreign public entities, in the extent that it is still compliant with its missions dedicated to the education and research community.

DATA

The infrastructure does not store data

Data access: restricted

Restrictions: Only aggregated data regarding the usage of the network are accessible to users.

Full cost

—
23.2 M€ in 2016

Personnel

—
64.1 FTE in 2016

International dimension

GEANT

Coordinator: Christian GRIMM

Coordinating country: Netherlands

Partner countries: DE, AT, AZ, BE, BA, BU, HR, DK, ES, EE, FI, GR, IE, IS, LV, LT, LU, MK, MT, NO, NL, PL, PT, CZ

Website: www.geant.org



Category: VLRI

Type of infrastructure: Distributed

Infrastructure location: Paris

Other sites: Rennes, Montpellier, Grenoble

French supporting institution: MESRI

Head of the infrastructure:

Patrick Donath

Construction: Operation:

1993

1993

Stakeholders in France: CNRS, CNES, CEA, NRA, INRIA, IRSTEA, ONERA, INSERM, CIRAD, IRD, BRGM

Contact in France:

patrick.donath@renater.fr

www.renater.fr

CC-IN2P3

IN2P3 Computing Center



Category: RI

Type of infrastructure: Monosite

Infrastructure location: Villeurbanne

Other sites: Bruyères-le-Châtel, Orsay, Montpellier

French supporting institution: CNRS

Head of the infrastructure:
Pierre-Etienne Macchi

Construction: **Operation:**

1986

1986

Contact in France:
contact@cc.in2p3.fr

cc.in2p3.fr

IN2P3 relies on the research infrastructure Computing Center of IN2P3 (CC-IN2P3) to accomplish its mission of setting up information systems in order to store, to make available to the scientific community, to processing and to valorize of the whole of the scientific data concerned, as well as their archiving.

CC-IN2P3 provides resources not only for nuclear physics and particle physics, but also for astrophysics and astroparticles. Among the major scientific collaborations that use its services are the LHC, GANIL/Spiral 2, LSST, CTA, KM3NeT all appearing on the TGIR/IR roadmap or that of ESFRI. Moreover, the computer technologies deployed for these needs have demonstrated a total adequacy with the needs of other fields (human sciences, bioinformatics, ecology...).

The CC-IN2P3 has developed state-of-the-art technical expertise in the areas of bulk data storage and high-throughput computing (HTC). It has a strong expertise in advanced technologies such as computing grids or cloud computing. It is one of the 14 international datacenters deployed under the Worldwide LHC Computing Grid project (W-LCG) and provides 11% of the global resources required for simulation, processing and data analysis of the four LHC experiments.

RELATIONS WITH ECONOMIC ACTORS/ SOCIO-ECONOMIC IMPACT

Partnership with the Dell/EMC manufacturer, which wishes to contribute, alongside the CC-IN2P3, to a support approach around massive data processing solutions and computing resources in a scientific framework.

DATA

Estimated volume stored in 2017: 67,054 To

Estimated volume stored in 5 years: 205,000 To

Embargo period: 48 months

Data access: restricted

Restrictions: The data access policy is defined by collaborations using CC-IN2P3 facilities that own them. This policy varies from one collaboration to another.

Full cost

—
13.7 M€ in 2016

Personnel

—
80.3 FTE in 2016

International dimension

W-LCG/EGI

Coordinator: Ian Bird, CERN

Partner countries: AU, AT, BE, DE, BR, CA, CL, CN, KP, DK, ES, EE, US, FI, GR, HU, IN, IS, IL, IT, JP, MY, MX, NO, PK, NL, PL, RO

Website: wlcg.web.cern.ch

FRANCE GRILLES

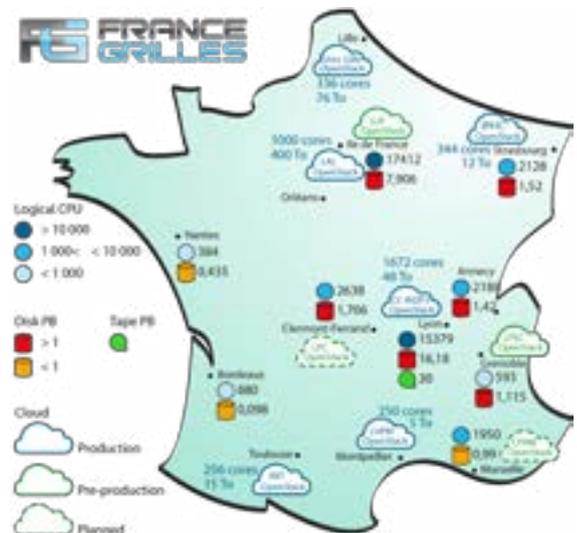


France Grilles

France Grilles is a multidisciplinary distributed computing Infrastructure that is open to all sciences and to developing countries. France Grilles is an open space for collaborations within and across disciplines and organizations. Operated by CNRS institute IN2P3, France Grilles' main objectives are as follows:

- establish and operate a national production grid and cloud infrastructure for high throughput data analysis and storage;
- contribute with the other countries involved to the EGI European e-infrastructure (www.egi.eu);
- strengthen synergies and collaborations between teams doing research on grids and clouds and teams using them for scientific production.

The infrastructure includes more than 40,000 processors and about 25 Pbyte of distributed storage on twelve sites in France. The France Grilles academic cloud federation gathers 10 sites together (seven in production status) and offers a total capacity of more than 4,000 cores and over 1 Pbyte of storage.



DATA

Estimated volume stored in 2017: 25,000 To

Estimated volume stored in 5 years: 100,000 To

No embargo period

Data access: non restricted

Full cost

1.7 M€ in 2016

Personnel

8 FTE in 2016

International dimension

EGI

Director: Yannick Legré

Partner countries: BE, HR, DE, ES, FI, FR, GR, IT, NO, NL, PL, PT, CZ, RO, UK, RU, SK, SI, SE, CZ, TR

Website: egi.eu

Category: RI

Type of infrastructure: Virtual

Infrastructure location: Paris

Other sites: Villeurbanne, Aubière, Strasbourg, Talence, Orsay, Gif-sur-Yvette, Palaiseau, Marseille, Le Crès, Toulouse, Villeneuve-d'Ascq, Grenoble, Nantes

French supporting institution: CNRS

Head of the infrastructure:

Vincent Breton

Construction: Operation:

2010

2010

Stakeholders in France: CEA, CPU, INRA, INRIA, INSERM, RENATER, MESRI

Contact in France:

vincent.breton@clermont.in2p3.fr

france-grilles.fr

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