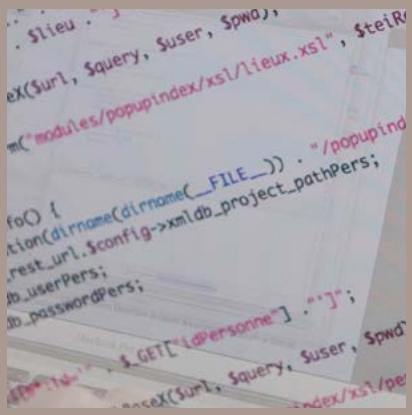
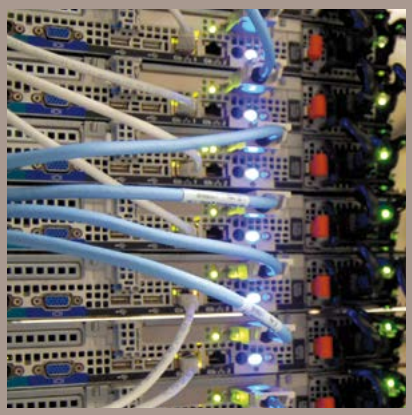
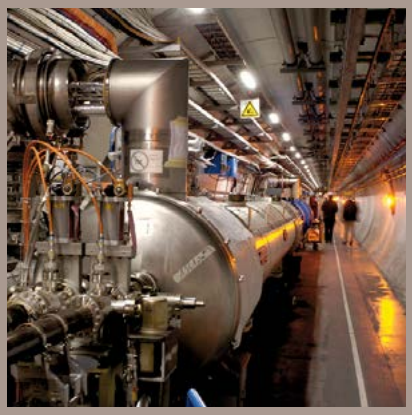
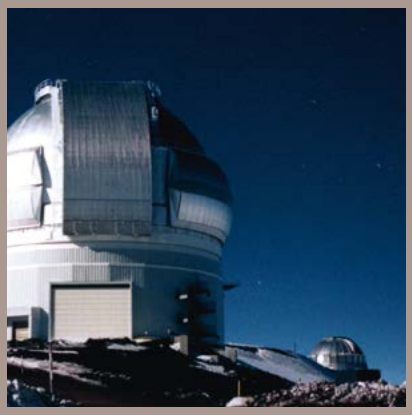





FRENCH NATIONAL STRATEGY
ON RESEARCH INFRASTRUCTURES
2016 EDITION

www.enseignementsup-recherche.gouv.fr

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

MINISTÈRE
DE L'ÉDUCATION
NATIONALE, DE
L'ENSEIGNEMENT
SUPÉRIEUR ET DE
LA RECHERCHE

FOREWORD



Thierry MANDON
Secretary of State, in charge of
Higher Education and Research

The dispositions announced at the end of the COP21 that has been held in Paris in December 2015 are a beautiful glimmer of hope for the future. These results that we owe partly to the tenacity of the negotiators, come deeper from a process of maturation of the awareness of climate change impacts by each participating country. This maturation is largely due to the work of scientists who, for twenty years, have tirelessly improved observations and refined their results in order to reach a broad consensus on the anthropogenic origin on the climate change. The scientists have achieved these results thanks to the sophisticated tools that they have gradually prepared for developing accurate observations and relevant modeling and simulations which were appropriate to the complex problems to be solved.

We use to call these tools "research infrastructures" (IR) or "very large research infrastructures" (VLRI). Their lifetime can last several decades and their national or local socio-economic impact is very substantial. For being erected, the VLRI need new technologies, highly skilled jobs with all that this implies in terms of training, and important financial resources, requiring cooperation at European or even international scale. Here is the purpose of achieving the roadmap of national, European or international IR: to have a controlled view on these particularly heavy investments. France has been a pioneer in multi-annual programming and management of these research facilities, through its research institutions and the Ministry of Research.

The European states concentrated their efforts in the ESFRI (European Scientific Forum for Research Infrastructures). France, which has actively participated to the ESFRI works for updating the roadmap for European research infrastructures which has been officially published in March 2016, also revisited, in parallel, the roadmap of its national facilities. This process generated an intense activity during 2015, in close partnership with research organisms and research alliances, starting from an analysis by major research areas that may be found in the chapters of this document, together with a strategic orientation for the coming years.

This work resulted in a list of Research Infrastructures as a real dashboard, allowing the state to have a solid basis for multi-year action plans. Today we are able to appreciate the benefit of this approach: the French infrastructures are of varied nature – but with common characteristics, as referred to this document. They reveal a wide spectrum of tools and equipment necessary for the development of large scientific sectors. They are a major asset of our country for maintaining its rank in the global competition and the Government will do its best to maintain a financial effort to meet the challenges. It remains to me to thank and to congratulate all the stakeholders in the scientific community, in research institutions and in ministerial teams for their exemplary work of coordination, their ability to self-organize and to take jointly decisions at the benefit of our country's interests.

INTRODUCTION

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 2016 edition of the National Strategy for the Research Infrastructures reflects the willingness of the State, through its major institutions of research and higher education, to meet the requirements of knowledge and innovation. The roadmap has been elaborated on the basis of a state of the art analysis by scientists from all fields and in accordance with the National Research Strategy. This is a unique opportunity to highlight a large variety of instruments, existing or planned, all of which must meet the same criteria of scientific and technological excellence, of efficiency and governance's transparency and of effective opening to a wider community of users.

Beyond this concern on access, the research infrastructures generate an exponentially increasing amount of data. Their ability to make their data accessible to the entire scientific community and beyond, to the whole society is one of their major challenges of the coming years. These infrastructures must finally consolidate their economic model including a full budget analysis, their positioning in the innovation ecosystem and the identification of their interactions with the socioeconomic players. This document presents the existing devices that constitute a real "strike force" at the heart of the national research strategy, as well as promising projects for building the future.

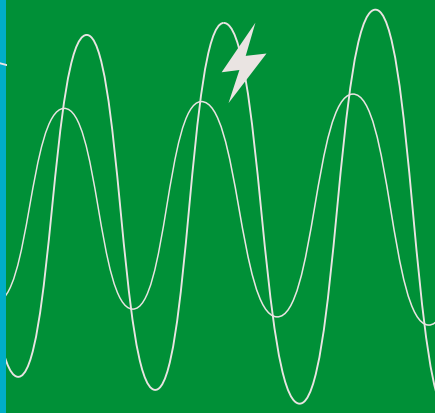
THE VARIOUS TYPES OF LARGE RESEARCH INFRASTRUCTURES
P. 6

SOCIAL SCIENCES AND HUMANITIES
P. 11



EARTH SYSTEM AND ENVIRONMENTAL SCIENCES
P. 21

ENERGY
P. 49



BIOLOGY AND HEALTH
P. 59

MATERIAL SCIENCES AND ENGINEERING
P. 89



ASTRONOMY AND ASTROPHYSICS
P. 109

NUCLEAR AND HIGH-ENERGY PHYSICS
P. 125

DIGITAL SCIENCES AND TECHNOLOGIES; MATHEMATICS
P. 135

SCIENTIFIC AND TECHNICAL INFORMATION
P. 147

ANNEXES
P. 157

THE VARIOUS TYPES OF LARGE RESEARCH INFRASTRUCTURES

A RICH AND VARIED LANDSCAPE

The nation roadmap for 2016 retained 95 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 in order to be closer to the scientific communities. 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. Four 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: fleets, networks of instrumented sites or platforms, collections, archives and scientific libraries;
- dematerialised: virtual research infrastructures, databases;
- 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.

Moreover, research infrastructures will in the future have to be able to:

- produce a multi-annual budget schedule as well as a consolidated budget that incorporates the full costs;
- make the data produced available, either immediately, or after an embargo period corresponding to the international practices of the field involved.

FOUR TYPES OF 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 LOLF and budget earmarking of the MENESR. 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 fall 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 concerning 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. Other than 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.

RESEARCH INFRASTRUCTURES AND DATA

The production, storage and making available of data are essential parameters of research today; this is particularly true for research infrastructures. Some are focused on digital research, as the subject of research in itself or for developing intensive computing tools, transmission or storage of data. Others have for purpose to make databases available, whether raw or enriched. In any case, they tend to become discoverable, usable and interoperable by an ever-increasing community. In certain fields, this making available is immediate and entirely public, according to a European directive. In others, an embargo period is current practice before dissemination.

RESEARCH INFRASTRUCTURES AND THE ROADMAP

LISTING ON THE ROADMAP

The national roadmap is a strategic steering tool of the government which is updated every four years according to a process that involves alliances, research performing organisations or supervisory institutions, after which listing may be recommended as an infrastructure or as a project. This process is described in the appendix of this document. Listing bears witness to the State's desire to structure the landscape of infrastructures of national significance. It represents a label of quality and recognition of its value in the National Research Strategy (SNR) but is not a substitute for the negotiations between partners: scientific communities, local governments, public institutions, the State and their equivalents abroad.

For the first time, the national roadmap displays a variety of precise informations such as international dimension, localization, volume and handling of data, or main budgetary informations.While the current result remains largely improvable, it provides a new track for the following of research infrastructures, whose informations will be updated regularly through their new on-line pages.

NATIONAL AND EUROPEAN ROADMAPS

The majority of the members of the European Union accomplish the same strategic exercise: ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri-national-roadmaps.

All have listed on their national roadmap their contribution to the European strategic roadmap (or ESFRI for "European Strategic Forum for Research Infrastructures". Its latest version published in 2016 has three categoris: 4 "emerging", 21 "projects" and 29 "landmarks", depending on their level of maturity. The numerous French participationsto these infrastructures are mentioned in the present document.



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 hthe 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 DARIAH European infrastructure and prepares the participation in CLARIN.

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

LPublic 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 CESSDA-FR- Réseau Quetelet. The VLRI is built around four departments corresponding to the European consortia CESSDA (Council of European Social Sciences Data Archives), ESS (European Social Survey), SHARE (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 centres are instruments for transforming SSH research based on interdisciplinarity and the development of project 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 VLRIs 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 scope of the SSH 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 project 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. E-RIHS is one of the new research infrastructures included in the ESFRI roadmap 2016.

LIST OF RESEARCH INFRASTRUCTURES SOCIAL SCIENCES AND HUMANITIES

TYPE	NAME	FULL NAME	ESFRI
VLRI	Huma-Num	Large facility for digital humanities	DARIAH (2006)
VLRI	Progedo	Data Production and Management	ESS (2006) CESSDA (2006) SHARE (2006) GGP (2016)
RI	*OpenEdition*[1]	*Open electronic edition in Humanities and Social Sciences*	
RI	RnMSH	Social Sciences and Humanities Centers Network	
Project	*ERIHS-FR*[2]	*European Research Infrastructure for Heritage Science*	*ERIHS (2016)*

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

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

HUMA-NUM

Large facility for digital humanities

Huma-Num is a very large research facility which aims to facilitate the digital turn in humanities and social sciences. To perform this mission, Huma-Num is built on an original organisation. It organises a collective dialogue with communities via consortia accredited by Huma-Num and provides a technological infrastructure, on a national and European scale, based on a wide network of partners and operators.

Through consortia of actors in scientific communities, Huma-Num promotes the coordination of the collective production of corpora of sources (scientific recommendations, technological best practices). It also develops a range of instruments to facilitate the processing, access, storage and interoperability of research data. This set of shared instruments fits into a Grid of services, a platform for the unified access to data (ISIDORE) and long-term archival facilities.

Huma-Num also produces Guides of Good Technical Practice for researchers, and regularly leads actions of assessment and training.

Huma-Num coordinates the participation of France in DARIAH (Digital Research Infrastructure for the Arts and Humanities).

SOCIO-ECONOMIC IMPACT

The facility works with the knowledge industry (Sparna, Lemonade & co, ActiveCircle, MONDECA ...), search engines developpers and big data (Antidot) services in order to improve ownership of the issus of the digital data economy by the SHS community (including the SSHC-Social Sciences and Humanities Centres).

DATA

Data flow: Between 1 Po et 2 Po

Data storage: The data is saved at Computing Center of IN2P3-CNRS and archived at CINES.

Accessibility: The data is on open access.

Presence in data networks: ISIDORE and NAKALA services (semantics web and OpenData services), DARIAH, PARTHENOS, Humanities at Scale, RnMSH, Openedition

Operating costs

1.4M€ (excluding personnel costs)

Personnel

11 FTE

International dimension

DARIAH-ERIC (Digital Research Infrastructure for the Arts and the Humanities), ESFRI Landmark www.dariah.eu

CLARIN-ERIC (Common Language Ressources and Technology Infrastructure), ESFRI Landmark www.clarin.eu

Coordinator: DARIAH-ERIC: FR, Humanum, CLARIN ERIC: NL

Partner countries: DARIAH: AT, DE, BE, CY, HR, DK, FR, GR, IR, IT, LU, MT, NL, SR, SI; CLARIN: AT, BG, CZ, DK, EE, FI, DE, GR, IT, LT, NL, NO, PL, PT, SI, SE, UK (French participation ongoing)



Type: VLRI

Headquarters location:
Paris

Other sites:
Lyon

Head of the Infrastructure:
Olivier BAUDE, Stéphane POUYLLAU

Construction:	Operation:
2013	2013

Stakeholders in France:
CNRS, AMU, Campus Condorcet

Contact in France:
direction@huma-num.fr

www.huma-num.fr

PROGEDO

Data Production and Management



Type: VLRI

Headquarters location:
Paris

Other sites:
Caen, Dijon-Besançon, Lille, Lyon, Nantes, Strasbourg, Toulouse

Head of the Infrastructure:
Pascal BULEON

Construction:	Operation:	Maintenance:
2014	2014	2016

Stakeholders in France:
CNRS, EHESS, FNSP, INED, GENES, Univ. Paris-Dauphine

Contact in France:
info@progedo.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 universties. 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.

SOCIO-ECONOMIC IMPACT

The data from large European surveys tackling the living conditions of elderly people, family, education and also values are exploitable for decision-making and public policy design.

DATA

Data storage: The data from the large European surveys (ESS, SHARE, GGP) are hosted by European archives. The data from CESSDA France are hosted by the servers of the partners of the Réseau Quetelet in France.

Accessibility: The European survey data of ESS, SHARE, GGP are on open access for the research community after subscription.

With regards to official statistics, there are two levels of access and security. Other aggregated and documented data from scientific surveys can be accessed for scientific purposes via INED and the CDSP.

Operating costs

4,249 M€ (excluding personnel costs)

Personnel

65.23 FTE

International dimension

CESSDA AS (Consortium of European Social Science Data Archives), ESFRI Landmark. Partner countries: NO (coord.), AT, CH, CZ, DE, DK, EL, FI, FR, LT, NL, SI, SE, UK, (Observer SK)

ESS ERIC (European Social Survey), ESFRI Landmark. UK (coord.), AT, BE, CZ, EE, FR, DE, IE, LT, NL, PL, PT, SI, SE, (Observer CH)

SHARE ERIC (Survey of Health, Ageing and Retirement), ESFRI Landmark. DE (coord.), AT, BE, CZ, GR, FR, IS, IT, NL, PL, SI, SE (Observer CH)

Website: www.cessda.net / www.europeansocialsurvey.org / www.share-project.org

RNMSH

Social Sciences and Humanities Centers Network

The Social Sciences and Humanities Centers Network (SSHCN) coordinates the activities of the 23 Centers at the national level. These are:

1. The construction of large platforms for the sharing of complementary resources, instruments and staff
2. The promotion of multidisciplinary projects (within the SSH and with other disciplines)
3. The implementation of activities promoting the transfer of research results;
4. The inclusion of European and international activities in the SSHC, in particular those of the research infrastructures Huma-Num and PROGEDO.

The main goal in terms of infrastructure is to organize five platforms within the network of the 23 Centers:

1. Spatio platform (spatial data);
2. Scripto platform (written data);
3. Visio platform (audiovisual corpus);
4. Cogito platform (platform of instruments for cognitive scientific research and of data from these or other instruments);
5. Data platform (quantitative data corpus) and promote the use of a sixth platform of internationalisation;
6. Platform Fundit.fr (website collecting and presenting all opening calls, research grants and fellowships available for scholars in the SSH on European and international level - platform developed by the RFIEA foundation together with the FMSH with the support of the CNRS).

SOCIO-ECONOMIC IMPACT

The last joint call of the CVT Athena (Consortium de Valorisation Thématique: Thematical Technology Transfer Consortium) and the SSHCN supported projects with an high economic impact in several fields: semantical intelligence, complex digital documentation treatment, and also development of a solution for lexical learning of a foreign language.

DATA

Accessibility: The data are on open access for the researchers (after variable modalities of subscription). Commercial use is excluded.

Presence in data networks: PUD (Plates-Formes Universitaires de Données: Database Platforms) within the TGIR PROGEDO, TGIR Huma-Num, DARIAH

Operating costs
—
4.9 M€

Personnel
—
403 FTE



Type: RI

Headquarters location:
Paris

Other sites:
Angers, Aix-en-Provence, Besançon, Bordeaux, Brest, Caen, Clermont-Ferrand, Corte, Dijon, Grenoble, Le Mans, Lille, Lorient, Lyon, Nancy, Metz, Montpellier, Nanterre, Nantes, Nice, Orleans, Poitiers, Rennes, Saclay, Saint-Denis, Saint-Etienne, Strasbourg, Toulouse, Tours, Vannes

Head of the Infrastructure:
Philippe VENDRIX

Construction:	Operation:
2006	2013

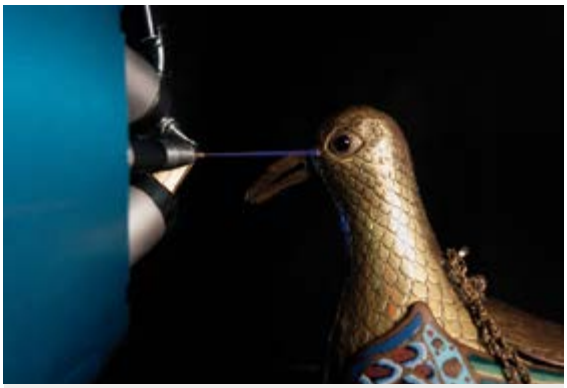
Stakeholders in France:
CNRS, les universités (ou COMUE), FMSH

Contact in France:
rnmsh@msh-paris.fr

www.msh-reseau.fr

E-RIHS-FR

European Research Infrastructure for Heritage Science



Type: Project

Headquarters location:
to be defined

Other sites:
Île-de-France

Contact person in France:
Isabelle PALLOT-FROSSARD, Loic BERTRAND

Construction:	**Operation:**
envisaged in 2019	*envisaged in 2019*

Stakeholders in France:
CNRS, FSP, INRIA, MCC, MNHN, UVSQ

Contact in France:
isabelle.pallot-frossard@culture.gouv.fr
loic.bertrand@synchrotron-soleil.fr

www.erihs.fr

ERIHS tackles experimental issues related to the knowledge and conservation of heritage materials (museum collections, monumental complexes, archaeological sites, archival collections, library resources, etc.), which are characterised by multiscale heterogeneity and long-term ageing (paintings, ceramics, glasses, metals, paleontological specimens, lithic materials, graphic documents, etc.).

ERIHS develops a transnational access to devices located in several European countries. These devices can be grouped into 4 platforms:
- FIXLAB: access to fixed facilities, which allow synchrotron, ion beam, laser analyses, etc.;
- MOLAB: access to mobile facilities, dedicated to studying materials in situ;
- ARCHLAB: access to archival collections from cultural organisations (scientific data, photos, notes, restoration reports, etc.);
- EXPERTLAB: setting-up of expert panels for initiating integrated projects for the study of heritage assets.

ERIHS is specifically involved in complex studies, for which the development of advanced technologies in analysis and high resolution imagery is needed, and which have a direct impact on preservation. Priority is given to the study of large corpora, collections and architectural complexes.

SOCIO-ECONOMIC IMPACT

Material sciences: material ageing;

Instrumental methodology: in imaging and spectroscopy, methods for non-invasive and portable techniques, combination of analytical methods;

Conservation-restoration methods: environmentally friendly processes;

Humanities and social sciences: analysis and archiving of digital data, reflexivity, epistemology, interdisciplinarity.

DATA

Data storage: The Centre national de calcul intensif, IDRIS, is one of the access providers of the infrastructure. The various aspects associated with the data will be set up in this partnership framework.

Accessibility: The data will be on open access for researchers.

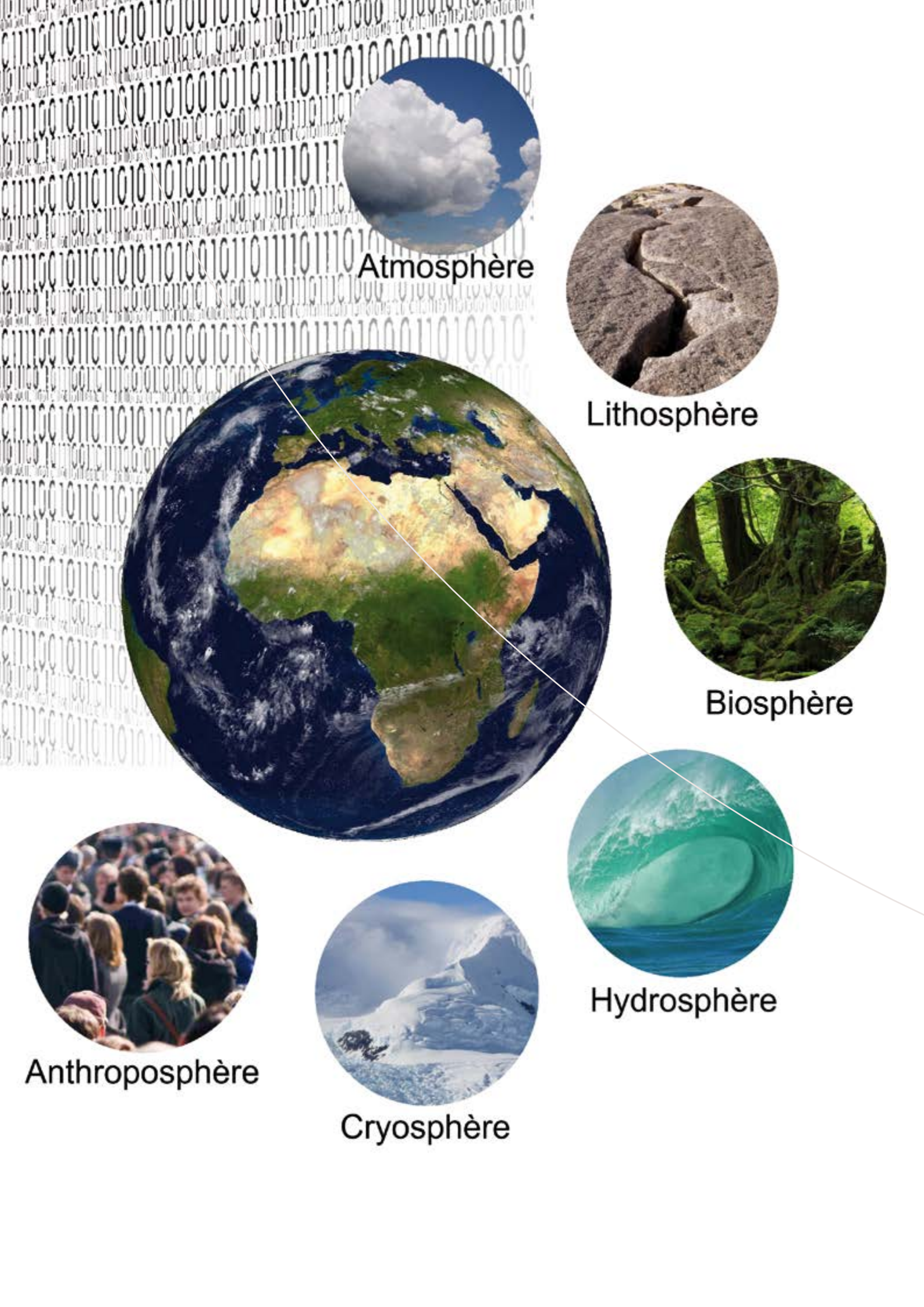
Presence in data networks: DARIAH, INRIA and IDRIS. Collaboration networks: PARTHENOS, Labex PATRIMA.

International dimension

E-RIHS, ESFRI Roadmap

Coordinator: Preparatory phase coordinated by IT

Partner countries: BE, CY, CZ, DE, ES, FR, HE, HU, IT, NL, PT, UK


Atmosphère
Lithosphère
Biosphère
Hydrosphère
Cryosphère
Anthroposphère

EARTH SYSTEM AND ENVIRONMENTAL SCIENCES



Earth System and Environmental Sciences

The research infrastructures (RI) in the Earth System and Environmental field investigate the forefront of knowledge on the processes at work within, and between the major compartments of the planet.

The data delivered make it possible:

1. to understand, model and create scenarios for climate, biodiversity and resources changes;
2. to monitor pollution and the impacts of it;
3. to develop research on adaptation or mitigation;
4. to assist in making decisions in light of the risk and evaluate the effects of public policy. They are geared towards producing services and economic development, in new sectors offered by energy and ecological transitions.

These RIs, which are often distributed, are diverse. Certain ones are logistics RIs that give access to the field such as fleets or stations. Others are networks of systems for observation, experimentation, collection and analysis. Others are virtual RIs devoted to access to and the making available of 1) scientifically valid data and 2) added value products such as models, maps, simulations...

The RIs are elaborated on a European (ESFRI roadmap, ENVRIplus[1] cluster) or international scale. They are built using systems that are accredited by research institutions, or the French Ministry for Education, Higher Education and Research (MENESR) for SOERE[2]. They are financially supported by the MENESR, the CGI or the institutions. The governance for them takes the diversity of the partner institutions into account. The AllEnvi Alliance provides coherence for the whole in light of the needs of the scientists, expressed during recurring prospective exercises.
The field is also marked by operational international organisations (IOs), providing downstream services in the sectors of the environment and space, such as ESA or EUMETSAT, or companies such as MERCATOR in partnership with the COPERNICUS programme. The IOs are listed in the scoreboard. Only the "European Centre for Medium-Range Weather Forecasts" is mentioned in the roadmap of RIs since it makes data and tools available to researchers, and opens towards training. Beyond this, note that the environmental sciences also make use of large analytical equipment (Soleil, ESRF...) and digital equipment (GENCI, Renater...).

"LOGISTICS" INFRASTRUCTURES

Logistics infrastructures render indispensable services to the entire national and often international community. They allow for data acquisition *in situ* and collection of samples. These are fleets: the **French Oceanographic Fleet** for boats, **SAFIRE** for aircrafts, contribution to the European consortium of drilling vessels (**IODP/ECORD**). Off the roadmap, mention can also be made of the "Ballons" fleet operated by CNES. These are also stations such as the Franco-Italian station **Concordia** in Antarctica. or the Franco-German Arctic station of Svalbard, off the roadmap, operated by IPEV with AWI.

DEEP EARTH

An observation RI, **RESIF/EPOS-FR**, brings together a large part of the national geophysical means devoted to studying the aleas and resources linked to the deep Earth processes (with occasionally, operational missions such as volcanological observatories). This highly integrative RI represents a structured model of basic systems operated by several institutions. Its ambition is to open up to other types of data. The Deep Earth Data Cluster "Form@ter" supplements the system and with a part of RESIF forms the mirror of ESFRI EPOS.

ATMOSPHERE

The observation RIs on the atmosphere, ESFRI mirrors, are supported by communities that have historically been structured around the study of greenhouse gases (GHG) via ICOS, the composition of the atmosphere, via **IAGOS**

1 Environmental Research Infrastructures providing shared solutions for science and society

2 Long-term observation and experimentation systems for environmental research

and the study of aerosols and of the reactive gases involved in the pollution of the air via **ACTRIS**. **ACTRIS-FR** brings together several SOERE and elementary observatories from diverse scientific bodies The atmospheric Data Cluster "Aeris" gathers all of the pre-existing centres and databases of the basic systems of the ACTRIS RI and other atmospheric data (IAGOS, Balloons and Satellites instrumentations).

OCEAN AND COASTLINE

The **I-LICO RI**, dedicated to the coastal and coastline environment, groups the basic systems of several institutions, built in the European vision of the JERICHO project. In the medium term, the oceanic field will be entirely covered by the observation RIs **EMSO** (deep ocean), **EURO-ARGO** (surface ocean) and **I-LICO** to which could be added an RI dedicated to the high seas aggregating several systems around the SOERE "Coriolis-time-differed-Oceanic-Observations". The data will be available through the Data Cluster "Ocean".

CRITICAL ZONE OF LAND SURFACES

The purpose of the **OZCAR** RI is to study the Critical Zone (interface zone between the altered rock and the tree canopy) in order to apprehend the mechanisms for storing and transferring energy and matter (water, carbon...) over different timescales, as well as how they change in light of global change and anthropisation. OZCAR allows for reinforced national structuring, as it combines several SOERE and basic systems. It has for objective to incorporate its data into the Land Surface Data Cluster "Theia" and in the middle term, to partner with an ESFRI project: e-LTER (*Long Term Ecological Research network*)[3].

BIODIVERSITY, ECOSYSTEMS

The landscape analysis currently reveals various tools for experimenting, collecting (sample archiving), analyzing and also observing ecosystems and biodiversity.
Two RIs for experimenting which make it possible to condition ecosystems and to monitor the processes at play under controlled forcing, are **ANAEE-Fr** (*in natura*) and **ECOTRONS** (mesocosms); together, they form the French mirror of ESFRI ANAEE.

The sample archiving RIs are: **RARE** which is a biological ressources centre for animals, plants and microorganisms, devoted to agronomics and **RECOLNAT** which covers naturalistic collections. They are part of a European perspective (MIRRI for microbial resources and the European RI project for collections). They carry strategic challenges entailing the use of biological resources for the purposes of research and development.
ECOSCOPE has for purpose to network biodiversity research observatories and to give access to observation, collection and experimentation data, in partnership with the European project EUBON and the IO GBIF (*Global Biodiversity Information Facility*).
As the research questions are at the junction between Physical Environment and Living, certain RIs are shared with the Biology – Health field. EMPHASIS-FR, a phenotyping platform for plants, is the mirror of the ESFRI of the same name. It supplements for agronomists and ecologists biology platforms that are rather supported by Aviesan, such as Metabohub. Two RIs are of great interest for the environmental sciences, these are on the one hand **IBISBA-FR** for the development of synthetic biology and on the other hand, **EMBRC-FR** (mirror of ESFRI) for marine biological resources.

VIRTUAL INFRASTRUCTURES FOR EARTH OBSERVATION

CliMERI-FR has for mission to create reference digital simulations for the World Climate Research Programme. On a national level, it aims to coordinate the major models of Météo-France and IPSL[4], to assess them and to produce projections for the future climate.
The **Earth System data and services Cluster** "Pôle de données" forms a RI as a project which has the ambition of offering a unique portal to the four clusters: atmosphere, ocean, deep Earth and land surfaces as well as new services and tools. This RI will make it possible to manage the full data cycle (in situ measurements and satellites) from their production to making it available and feeding national, European and international data bases (COPERNICUS, GEOSS...). An opening is expected towards a data cluster on biodiversity using ECOSCOPE.

3 Outside the roadmap, the SOERE "Réseau des zones ateliers" makes it possible to study socio-ecosystems in all of their dimensions.

4 Institut Pierre-Simon Laplace

LIST OF RESEARCH INFRASTRUCTURES
EARTH SYSTEM AND ENVIRONMENTAL SCIENCES

TYPE	NAME	FULL NAME	ESFRI
IO	CEPMMT	European Centre for Medium-Range Weather Forecasts	
VLRI	Concordia	French – Italian Antarctic Station	
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	The French Oceanographic Fleet	
VLRI	ICOS	Integrated Carbon Observation System	ICOS (2006)
RI	ACTRIS - FR	Aerosol, Cloud and Trace Gases Research Infrastructure - France	ACTRIS (2016)
RI	ANAEE - FR	Analyses and Experimentation on Ecosystems – France	ANAEE (2010)
RI	ClimERI-FR	National Infrastructure for Earth System Climate Modelling-France	
RI	ECOSCOPE	Observations and Datasets Center for Research on Biodiversity	
RI	ECOTRONS	Ecotrons	ANAEE (2010)
RI	*EMBRC-FR*[1]	*National Marine Biological Resource Center*	*EMBRC (2008)*
RI	*EMPHASIS France*[2]	*European Multi-environment Plant pHenomics And Simulation InfraStructure -France*	*EMPHASIS (2016)*
RI	EMSO - France	European Multidisciplinary Seafloor and water column Observatory - France	EMSO (2006)
RI	IAGOS - France	In-service Aircraft for Global Observing System	IAGOS (2006)
RI	I-LI-CO	Seashore And Coastal Research Infrastructure	
RI	OZCAR	Critical Zone Observatory, Research and Applications	E-LTER (2016)
RI	RARE	Agronomic Resources for Research	
RI	RECOLNAT	French Naturalist Collections Network	
RI	RESIF/EPOS	French seismic and geodetic network /European Plate Observing System	EPOS (2008)

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".

TYPE	NAME	FULL NAME	ESFRI
RI	SAFIRE	French Airborne Environment Research Service	
Project	*IBISBA-FR*[3]	*Industrial Biotechnology Innovation and Synthetic Biology Accelerator*	
Project	Pôle de données	Data and Services Center for Earth System Modelling	

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

CEPMMT / ECMWF

European Centre for Medium-Range Weather Forecasts



Type: International Organisation

Headquarters location:
Reading, UK

Contact person in France:
Jean-Marc LACAVE

Construction:	Operation:
1975	1979

Stakeholders in France:
MENESR

Contact in France:
jean-marc.lacave@meteo.fr

www.ecmwf.int

The European Centre for Medium-Range Weather Forecasts (ECMWF) is an independent intergovernmental organisation supported by 34 states.The organisation was established in 1975 and now employs around 280 staff members from more than 30 countries. It is the recognised 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 NWP education and training.

ECMWF is in charge of two Copernicus services: atmospheric environment service (CAMS) and climate change service (C3S).

ECMWF is based in Reading, UK.

SOCIO-ECONOMIC IMPACT

Meteorology, Alert and prevision services, Air quality, Climate services

DATA

Data flow: Several PetaBytes per annum

Data storage: 170 Pb as of March 2016

Accessibility: Free access for research and education purposes. Free and full access for public services. Free, full and open access for Copernicus services. Paying access for commercial services.

Presence in data networks:
- EUROSIP: multi-model seasonal forecasting system based on the forecasts of ECMWF, UK Met Office, Météo-France and NCEP
- Copernicus atmosphere environment and climate change services
- Archiving ensemble forecasts of ten global centers provided in the framework of the WMO TIGGE project
- Hosting the platform of EFAS information system (European Flood Forecasting system), a Copernicus Service

Operating costs

82.74 M€
including 8.7 M€ of French contribution

Personnel

324 FTE

International dimension

Coordinator: Florence Rabier, Director General

Partner countries:
Members:AT, BE, HR, DK, FI, FR, DE, GR, IS, IE, IT, LU, NL, NO, PT, RS, SI, ES, SE, CH, TR, GB
Partners: BG, CZ, EE, MK, HU, IL, LV, LT, ME, MA, RO, SK

Website: www.ecmwf.int

CONCORDIA

French-Italian Antarctic Station

Concordia is a French-Italian polar research station located on the Antarctic continental plateau. It is the only European station into 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 of unique characters:
- 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 60 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.

SOCIO-ECONOMIC IMPACT

Some activities related to logistics and maintenance of the station may be 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).

Construction costs

34 M€ including 17 M€ of French contribution

Operating costs: 10.6 M€ including 50% of French contribution

Personnel

16 FTE

International dimension

Partner countries: FR, IT Programma Nazionale Di Ricerche in Antartide (PNRA) - Italie (MIUR, ENEA, CNR)

Website:
www.enea.it/en/research-development/climate-and-the-environment/expeditions-in-antarctica-and-research-in-polar-areas



Type: VLRI

Headquarters location:
"Dome C", Antarctic (75°06'S - 123°21'E)
on the continental plateau, 1,100 km
from the French station "Dumont d'Urville"

Head of the Infrastructure:
Yves FRENOT

Construction:	Operation:
1998	2005

Stakeholders in France:
GIP IPEV (MENESR, MAEDI, CNRS, CEA, CNES, Ifremer, Météo-France, TAAF, EPF)

Contact in France:
dirpol@ipev.fr

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

ECORD / IODP

European Consortium for Ocean Drilling Research/ International Ocean Discovery Program



Type: VLRI

Headquarters location:
Aix-en-Provence

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Gilbert CAMOIN

Construction:	Operation:
2013	2013

Stakeholders in France:
CNRS

Contact in France:
camoin@cerege.fr
ema@cerege.fr

www.ecord.org

www.iodp-france.org

ECORD is an European consortium. This consortium is involved in IODP (International Ocean Discovery Program; 26 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 drillships 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.

SOCIO-ECONOMIC IMPACT

Scientific drilling provides fundamental data to various industrial sectors (resources, biotechnologies etc.). ECORD and IODP innovate in terms of technological development concerning the drilling material and techniques in collaboration with the industrial sector (large companies and SMEs) and within the frame of poles of competitiveness.

DATA

Data flow: Several TB/year

Presence in data networks: All data and cores collected during drilling cruises are stored in three core repositories (College Station – USA -, Kochi – Japan -, Bremen – Europe -) which are open to the science community after a moratorium period of one year after the completion of the expedition.

Operating costs
—
4.5 M€

Personnel
—
5 FTE

International dimension

Coordinator: Gilbert Camoin, FR, for ECORD consortium

Partner countries: IODP = ECORD consortium (DE, AT, BE, CA, DK, ES, FI, FR, IE, IL, IT, NO, NL, PL, PT, UK, SE, CH) + US, BR, CN, KR, IN, AU, NZ

Website: www.ecord.org, www.iodp.org

EURO-ARGO

European contribution to Argo programme

Argo is an international infrastructure of more than 3,500 profiling floats that measure temperature and salinity throughout the deep 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 array 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 array 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 an array 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.

SOCIO-ECONOMIC IMPACT

Socio-economic impacts include the wide range of ocean services developed through the Copernicus Marine Service. Strong partnerships exist with SMEs on marine technology and sensors, in particular with the French NKE SME which is the main manufacturer of Argo floats in Europe.

DATA

Data flow: Data volume < 100 MB/day

Data storage: The total volume of Argo data is about 500 GB.

Accessibility: via the Coriolis data center; also sent in real time to the WMO (World Meteorological Organization) GTS (Global Telecommunication System). Data are available on line from www.argodatamgt.org/Access-to-data. About 1,300 single users are accessing data each month.

Presence in data networks: Coriolis, Mercator-Ocean. European marine infrastructures and integrated data systems (SeaDataNet and EMODnet, Copernicus Marine Service). International Argo program (GOOS).

Operating costs

2.2 M€
including 12 FTE

Personnel

12 FTE

International dimension

EURO-ARGO ERIC, ESFRI Landmark

Coordinator: Yves Le Traon, FR

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

Website: www.argo.ucsd.edu / www.jcommops.org/argo



Type: VLRI

Headquarters location:
Brest

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Sylvie POULIQUEN, Pierre-Yves LE TRAON

Construction:	Operation:
2001	2011

Maintenance:
New floats are deployed every year.

Stakeholders in France:
Ifremer, CNRS, SHOM, Météo-France, IRD, CNES, IPEV (Consortium Coriolis)

Contact in France:
sylvie.pouliquen@ifremer.fr

www.euro-argo.eu

FOF

The French Oceanographic Fleet



Type: VLRI

Headquarters location:
Toulon, Brest

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Olivier LEFORT

Creation:	Exploitation:
2011 (for VLRI)	1960 (first vessels)

Maintenance:
Fleet evolution plan covering 20 years

Stakeholders in France:
CNRS, IFREMER, IRD, IPEV,
Marine Nationale, TAAF

Contact in France:
olivier.lefort@ifremer.fr

www.flotteoceanographique.fr

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

It can carry in inshore and offshore marine scientific research and observations in environmental sciences in all fields of oceanography: marine geosciences, physical and biological oceanography, geochemistry and organic chemistry oceans, paleoclimatology, marine biodiversity, etc. It participates in the training of students.

It contributes to public service missions for monitoring and expertise: hydrography, coastal environment, fisheries, biodiversity, evaluation of natural risks (seismic, volcanic gravity, tsunamis).

Types of operations and observations:
- physico-chemical measurements of the water column;
- bathymetry and mapping, seismic;
- imaging;
- sampling and analysis of samples (water, fauna, flora, sediment coring up to 70 meters deep, seafloor surface rocks and minerals);
- installation and maintenance of seafloor observatories;
- measures on the way (meteorology, current measurements, geophysics...).

SOCIO-ECONOMIC IMPACT

Partnerships for the design, construction and maintenance of vessels, underwater vehicles, sensors and onboard scientific instruments.

Scientific partnerships in the fields of marine and submarine technologies (sensors, autonomous robots, renewables), biotechnology, mineral resources (polymetallic sulphides) and energy (oil in particular).

DATA

Data storage: Data center in Brest (Ifremer)

Accessibility: Via the website www.flotteoceanographique.fr/Documentation

Presence in data networks: National portals: Sismer (Ifremer), ocean data Pole. European portals: Coriolis (www.coriolis.eu.org), SeaDataNet (www.seadatanet.org), Emodnet (www.emodnet.eu)

Construction costs
—
600 M€ (value estimation if new vessels)
Operating costs: 75 M€

Personnel
—
530 FTE

International dimension

"Ocean Facilities Exchange Group", Eurofleets

Website: www.ofeg.org, www.eurofleets.eu

ICOS-FR

Integrated Carbon Observation System

ICOS is a distributed research infrastructure providing harmonized measures at the European level on the carbon cycle, emissions and atmospheric concentrations of greenhouse gases. ICOS integrates networks of measurements made 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 responsible for the centralized data processing, quality control and training.The Atmosphere Thematic Centre is led by France, the Ecosystem Thematic Centre by Italy and the Centre Ocean Theme by Norway. Two other centers based in Germany provide the reference gas for the networks and perform analysis of air samples collected in flasks. The headquarters are based in Finland and a carbon portal is located in Sweden.

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 objective of ICOS is to measure the long term essential parameters of the carbon cycle and the main greenhouse gases. The coherent data set obtained allows research on greenhouse gas fluxes (natural or anthropogenic) and the multi-scale processes that determine them. ICOS will detect changes in regional greenhouse gas fluxes, measure the impact of extreme weather events, emission reduction policies and will reduce uncertainty in Earth system models and their predictions.

SOCIO-ECONOMIC IMPACT

ICOS is working with the service industry related to environmental and climate data. ICOS also collaborates with SMEs in the development, testing and deployment of sensors and innovative instrumentation systems for measuring greenhouse gases.

In France, an Industrial Chair involving Thales Alenia Space and Veolia was created to develop innovative methods for quantifying greenhouse gas emissions.

DATA

Accessibility: Open data policy: ICOS data accessible for all users

Construction costs
—
18 M€
Operating costs: 7 M€

Personnel
—
5 FTE

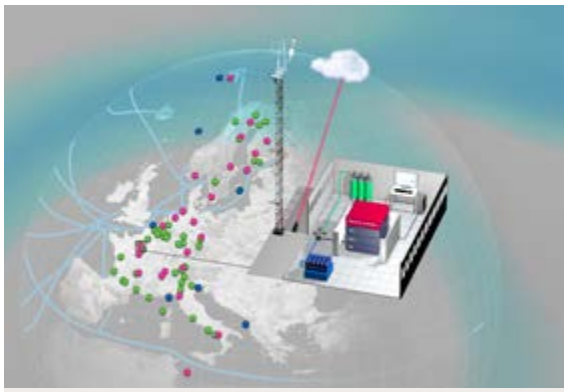
International dimension

ICOS ERIC, ESFRI Landmark

Coordinator: Kutsch Werner, FI

Partner countries: Members: DE, BE, FI, FR, IT, NO, NL, SE, Observer: CH

Website: www.icos-ri.eu



Type: VLRI

Headquarters location:
Saclay

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Philippe CIAIS

Construction:	Operation:
2013	2016

Maintenance: Upgrade every 5 to 7 years

Stakeholders in France:
CEA, CNRS, INRA, Univ. Versailles St-Quentin, Observers: Andra, Collaborations: Universities of Avignon, Aix-Marseille, Antilles, Bordeaux, Clermont-Ferrand, Guyane, La Réunion, Montpellier, Orléans, Paris-Saclay, Paris-Sud, Paris 6, Reims, Toulouse

Contact in France:
philippe.ciais@lsce.ipsl.fr

icos-atc.lsce.ipsl.fr

ACTRIS-FR

Aerosol, Cloud and Trace Gases Research Infrastructure - France



Type: RI

Headquarters location:
Paris

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Jean-François DOUSSIN

Construction:	Operation:
2016	2018

Stakeholders in France:
CNRS, ANDRA, CEA, CNES, IPEV, INERIS, Météo France, IRSN, Univ. Grenoble-Alpes, Univ. Toulouse, Univ. Clermont-Ferrand, Institut Pierre-Simon Laplace, Univ. Pierre et Marie Curie, Univ. Versailles St.-Quentin, Univ. de Lille, Univ. de la Réunion, École Nationale Supérieure des Mines de Douai

Contact in France:
Jean-francois.doussin@cnrs-dir.fr

ACTRIS will be the pan-European initiative for observation of atmospheric aerosols, clouds, and trace gases and 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 current capacity to analyse, 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.

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 exploration of the relevant atmospheric processes and technological innovation.

SOCIO-ECONOMIC IMPACT

Observation technologies and methodologies including hardware and software are the building blocks of ACTRIS which gathers expert leaders in instrumentation for aerosol, cloud and trace gases measurements. ACTRIS has already established a strong partnership with 11 private companies interested in accessing ACTRIS facilities, in technological innovation and in new metrological norms.

DATA

Data flow: Evaluation pending

Data storage: 1 TB

Accessibility: ACTRIS is following an open data policy and access to data will be given at no cost for the users. It is possible that some data products and services will be accessible to members only

Presence in data networks: ACTRIS-FR relies upon the AERIS data center and the ACTRIS data center

Construction costs

10 M€
Operating costs: 1.88 M€

Personnel

63 FTE

International dimension

ACTRIS, ESFRI Roadmap

Coordinator: Markku Kulmala, FI

Partner countries: BE, BG, BY, CH, CY, CZ, DE, ES, FI, FR, GR, HU, IE, IT, NL, NO, PO, RO, SE, UK

Website: www.actris.eu

ANAEE-FR

Analyses and Experimentation on Ecosystems - France

AnaEE France (Analysis and Experimentation on Ecosystems-France) is a national research infrastructure for the experimentation on terrestrial and aquatic continental ecosystems. It is coordinated by CNRS and INRA, and constitutes the french contribution to the European AnaEE infrastructure that is part of the ESFRI roadmap.

The infrastructure aims at understanding and predicting the biodiversity and ecosystem dynamics following an integrated approach that combine life and environmental sciences.

AnaEE-France gathers experimental platforms offering three levels of environmental controls: ecotrons (2), semi open environment to control part of the fluxes (4) and in natura experimental sites (20) covering various ecosystems (lake, forest, grassland, cropland) in metropolitan France and tropical areas. To enhance observation capacity, AnaEE-France offers analytical platforms and mobile instrument that can be implemented in the experimental sites. In addition to the experimental facilities, AnaEE-France offers modelling platforms to implement existing model or develop new ones. To promote data reuse, they are stored in open information system through internet.

SOCIO-ECONOMIC IMPACT

AnaEE France services are establishing a dozen number of formal agreements with industrial partners every year. For example, the PRO service has as industrial partner « Veolia Environnement » since 1998 in the framework of evaluating the effects on agrosystems of supplementing with residual organic products.

DATA

Data flow: several TB/an

Data storage: Data are stored on a SI common for all long-term experimental platforms and metadata are archived for the other types of experimental platforms

Accessibility: AnaEE-France aims to release the data to the academic world within 1 and 5 years given the platforms and contexts through a web portal

Presence in data networks: ECOSCOPE, ICOS

Construction costs

Between 0.5 et 30 M€ per plateform depending on its type

Operating costs: Between 10 and 100 k€ per plateform

Personnel

Between 1 et 4 persons per plateform

International dimension

AnaEE ESFRI Roadmap

Coordinator: Abad Chabbi, FR

Partner countries: FR, UK, NO, DK, TR, IT, CZ, BE, FI, SE, IL, EE, PO

Website: www.anaee.com



Type: RI

Headquarters location:
Moulis

Other sites:
Distributed research infrastructure including several sites in France metropole, 2 sites in French Guyane, 1 site in Brazil, 1 site in Congo, 1 site in Thailande

Head of the Infrastructure:
Jean CLOBERT

Construction:	Operation:
2012	2012

Maintenance: 2016

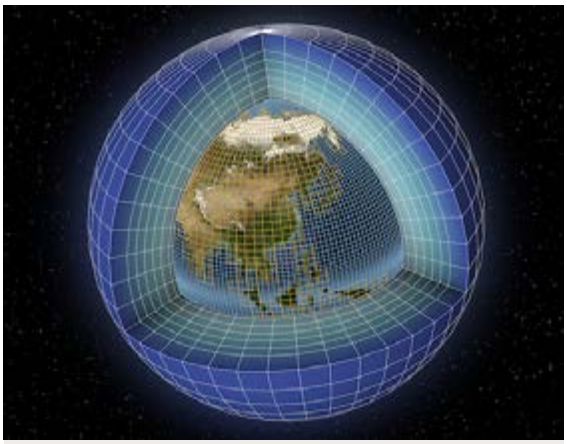
Stakeholders in France:
CNRS, INRA, Univ. Grenoble.
Affiliated partners: ENS, Univ. Bourgogne, Univ. Savoie, Univ. Avignon

Contact in France:
jean.clobert@ecoex-moulis.cnrs.fr

www.anaee-france.fr

CLIMERI-FRANCE

National Infrastructure for Earth System Climate Modelling - France



Type: RI

Headquarters location:
Paris-Saclay

Other sites:
Toulouse

Head of the Infrastructure:
Sylvie JOUSSAUME

Construction:	Operation:
2016	2016

Stakeholders in France:
CNRS, CEA, Météo-France, UPMC, IRD, Cerfacs, GENCI

Contact in France:
sylvie.joussaume@lsce.ipsl.fr

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 their 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 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 as well as data archiving and 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 as well as of simulations performed over France, in the frame of the development of climate services at national level coordinated by AllEnvi .

SOCIO-ECONOMIC IMPACT

Climate projections constitute an essential source of information for climate change mitigation and adaptation policies and are used as well by climate service providers (AllEnvi, Copernicus). In particular, SMEs benefit from these in assisting different sectors of the economy.

DATA

Data flow: The previous round of simulations led, all in all at international scale, to a volume of 2 PB. The IPSL node distributed between 10 and 30 TB/month to different users at national, European and international level. Next coordinated experiments, still in the process of being defined, are estimated to produce a twenty-fold higher volume of data, of the order of 40 PB, 10% of which on the French side.

Data storage: The data to be shared are only a fraction of the total volume generated. IPSL, for instance, will therefore need 14 PB for total storage of data to be analyzed, and Meteo-France around 10 PB.

Accessibility: French and European data are accessible for both research and commercial purposes.

Presence in data networks: International database for model results: Earth System Grid Federation (ESGF)

Construction costs

8 M€
Operating costs: 8.7 M€

Personnel

53 FTE

International dimension

European dimension under construction Earth's Climate System Modelling – European Research Infrastructure (CliM-ERI)

Coordinator: Sylvie Joussaume, FR

Partner countries: FR, DE, IT, NL, NO, ES, SE, UK, IE, FI, DK

ECOSCOPE

Observations and Datasets Center for Research on Biodiversity

The scientific aim is to document andunderstand the state and trends of biodiversity and ecosystem services, and to build scenarios for the future. In this framework, ECOSCOPE promotes the complementarity of observationsand links between research observation systems that vary by spatial and temporal scales, measured variables, studied ecosystems, levels of organization and data sources.ECOSCOPE is thus setting up an entry point of access to observations and datasets for research on biodiversity, in cooperation with existing initiatives and taking into account the entire data life cycle, to facilitate links between data producers and users.

The missions are:

1. to provide access to metadata and biodiversity observation datasets, services and products (not raw data);
2. to facilitate harmonization and contribute to the national efforts to engage networks and observatories in a joint approach based on the concept of Essential Biodiversity Variables (EBVs), while observatories remain under their institutional tutelage;
3. to contribute to national and international initiatives dedicated to data and biodiversity observation, to encourage openness to other research communities as well as to actors who needscientific expertise to support public decisions.

SOCIO-ECONOMIC IMPACT

The observation systems involved in ECOSCOPE mainly concern researchers, but also involve socio-economic actors who are interlinked with research (mostly for domestic animal, plant and forest genetic resources) and citizen sciences framed by academic researchers. ECOSCOPE also works in close collaboration with the Information System on Nature and Landscape, a national initiative which interacts with the local and regional stakholders involved in the observation, management and conservation of biodiversity.

DATA

Data flow: Several TB/year

Data storage: The data managed in the ECOSCOPE portal are metadata.

Accessibility: Metadata are freely available on line, as well as the corresponding datasets whenever possible, depending on the observatories.

Presence in data networks: ECOSCOPE is an Associated Partner of EU BON; is listed Biodiversity Observation Network (BON) by GEO BON, the biodiversity component of the Global Earth Observation System of Systems (GEOSS); and is establishing links with national and international information systems (INSPIRE GeoCatalogue, MetaCat from DataONE, AnaEE-France, some INEE's initiatives, GBIF-France, CRB-Anim, OCEANOMICS... to foster the reuse of datasets.



Type: RI

Headquarters location:
Paris

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Aurélie DELAVAUD

Construction:	Operation:
2011	2012

Stakeholders in France:
FRB, BRGM, CIRAD, CNRS, IFREMER, INRA, IRD, IRSTEA, MNHN

Contact in France:
ecoscope@fondationbiodiversite.fr

www.fondationbiodiversite.fr/ecoscope/fr

ECOTRONS

Ecotrons



Type: RI

Headquarters location:
Ile-de-France region

Other sites:
Montpellier

Head of the Infrastructure:
Jacques ROY

Construction:	Operation:
2009	2011

Stakeholders in France:
CNRS, ENS Paris/Regional Council Île-de-France, Regional Council Occitanie

Contact in France:
jacques.roy@cnrs.fr

www.ir-ecotrons.cnrs.fr

Experimentation on ecosystems is a prominent scientific challenge that requires mastering the dynamics of complex adaptive systems as well as to control and measure various physical, chemical and biological parameters. An Ecotron is defined as an experimental system made of replicated units that allow simultaneously the conditioning of the environment of natural or artificial ecosystems and the measurement of key processes generated by living organisms in these ecosystems, including the flow of matter and energy. The basic principle of an Ecotron is to confine ecosystems inside chambers wholly or partially sealed and capable to generate a range of physical and chemical conditions relevant of land or water, continental or marine environments. This confinement allows to measure accurately the exchange of molecules between the ecosystem compartments and thus to provide information on ecosystem processes.

The Ecotrons are characterized by a larger number of experimental units (at least 12 per platform) allowing to study interactions between environmental factors in a robust statistical framework in controlled conditions. They can simulate a range of environments much larger than what was done in previous infrastructure including low temperatures, low oxygen partial pressure, specific spectral composition of light, fast and slow changes. This offers the possibility to study new types of ecosystems and to test original hypotheses. The Ecotrons also propose a capacity of online measurement of ecosystem processes, including biogeochemical cycles and the use of isotopes, which is unparalleled in other infrastructures. This will allow a deeper understanding to develop predictive models of ecosystem functioning.

SOCIO-ECONOMIC IMPACT

The innovation domains concerned are biotechnologies, agronomy, ecological engineering, sensors and environmental conditioning developments. The infrastructure is collaborating with industrial partners and informally associated to the "Pôles de compétitivité" eau et végétal. About 1 to 2 patents are deposited every two years and innovation prizes have been awarded jointly with companies.

DATA

Data flow: 200 MB per week

Data storage: 4 TB

Accessibility: on line

Presence in data networks: AnaEE-France database

International dimension

AnaEE ESFRI Roadmap

Coordinator: Abad Chabbi, FR

Partner countries: UK, NO, DK, TR, IT, CZ, BE, FI, SE, IL, EE, PO

Website: www.anaee.com

EMPHASIS-FR

European Multi-environment Plant pHenomics And Simulation InfraStructure

Emphasis-France develops tools and methods for analysing the genetic variability of plant responses to environmental stresses associated with climate changes via:

1. Phenotyping platforms for thousands of plants/microplots, with a temporal definition of minute to days, together with environment as sensed by plants.
   - Robotized platforms equipped with imaging systems in controlled conditions, for architectural and functional analyses;
   - Fields for detailed analyses of micro canopies with manipulation of the plant environment (free air CO_2 enrichment, rainout shelters) equipped with precise canopy imaging systems;
   - etworks of fields equipped with sensors and mobile imaging systems (UAV, phenomobile) in a range of climatic conditions;
2. Distributed information system designed for acquisition, organisation and storage of the data collected in the whole infrastructure, and for exchanging datasets between nodes via webservices. This IS is in relation with those of other infrastructures;
3. Tools for data analysis in terms of:
   - high throughput evaluation of the quality of millions of datapoints;
   - statistical analyses of temporal data corresponding to thousands of plants/microplots;
4. Models for simulating plants/canopies, able to infer the performances of hundreds of genotypes in hundreds of European climatic scenarios, from data obtained in phenotyping platforms.

SOCIO-ECONOMIC IMPACT

Technology. Phenotyping and precision agriculture are emerging markets. Phenome/Emphasis has resulted, in three years, in one spin-off, in several patents and in the commercialization of novel products by French and European SMEs.

Seed companies and farmer advice. Providing accesses to platforms and methods, mutual information on strategic issues, industrial advisory board.

DATA

Data flow: 100 TB per year

Data storage: 2-3 PB in 2020

Accessibility: Minute to week, depending on datasets

Presence in data networks: Agreement in discussion with France Grille and EU Grids

International dimension

EMPHASIS ESFRI Roadmap

Coordinator: Uli Schurr, DE

Partner countries: DE, FR, UK, BE

Website: Under construction: www.plant-phenotyping.org/Facts



Type: RI

Headquarters location:
Montpellier

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
François TARDIEU

Construction:	Operation:
2012	2013

Stakeholders in France:
INRA, Arvalis Institut du Végétal, CEA, CNRS, Terres Inovia

Contact in France:
francois.tardieu@supagro.inra.fr

www.phenome-fppn.fr

EMSO-FR

European Multidisciplinary Seafloor and water column Observatory



Type: RI

Headquarters location:
Paris, Brest

Other sites:
In the sea: Ligurian, Azores, Marmara (in preparation)

Head of the Infrastructure:
Mathilde CANNAT, François ROLIN

Construction:	Operation:
1991	In progress between 1991 and 2017

Stakeholders in France:
CNRS, Ifremer

Contact in France:
cannat@ipgp.fr
jrolin@ifremer.fr

www.emso-fr.org

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) provide an open access to data through disciplinary portals and real time access.

EMSO network aims at acquiring time series in deep seas for the main scientific objectives to:

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 marine technology developments under high pressure.

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

EMSO ERIC lead by Italy and supported by France is being established in 2016.

SOCIO-ECONOMIC IMPACT

Industrial opportunities to provide fixed cabled or relocatable infrastructures, connected instruments, data base constitution and associated services. The market of monitoring before and during production of oil fields, deep-Sea mining and marine renewables is targeted. Promoting SMEs is ensured by inter-Carnot Captiven project and the 2 French Maritime Clusters (Poles Mer).

DATA

Data flow: < 0.5 TB/year. However, the flux is increasing with the connection of cameras, seismometers and ecosounders (active acoustics).

Data storage: SISMER and RESIF

Accessibility: Through disciplinary portals and EMSO portal (EMSO France)

Presence in data networks: Pole Océan according to the new "Pôles de données" of Environment Research in France. EMODNET/Copernicus, SeaDataNet, GEO/GEOSS, RESIF/EPOS for Earth science Data, METEO FRANCE for meteorological data

Construction costs

0.313 M€
Operating costs: 0.276 M€

Personnel

1.340 M€

International dimension

EMSO, ESFRI Landmark

Coordinator: Paolo Favoli, IT

Partner countries: Members: IT, UK, ES, RO, PT, GR, IE. **Observers:** DE, NL

Website: www.emso-eu.org

IAGOS

In-service Aircraft for Global Observing System

IAGOS will establish and operate a distributed infrastructure for long term observations of atmospheric composition in reactive gases (ozone, carbon monoxide, nitrogen oxides), greenhouse gases (water vapor, carbon dioxide, methane, ozone), aerosols and clouds particles, on a global scale from a fleet of 10-20 long range in-service aircraft of internationally operating airlines.

IAGOS builds on the scientific and technological experience gained within the research projects MOZAIC (Measurement of Ozone and Water Vapour on Airbus in-service Aircraft), which was funded by the EC between 1993 and 2004 under FP 4 and FP 5, and CARIBIC (Civil Aircraft for the Regular investigation of the Atmosphere Based on an Instrument Container). IAGOS was initiated by JUELICH, CNRS, Météo-France, and Airbus, together with a growing community of European research institutions and international airlines. IAGOS will provide a data base for users in science and policy, including near real time data provision for weather prediction and air quality forecasting. It will provide data for weather, air quality and climate models, including those used in the Copernicus Atmosphere Monitoring Service (CAMS), the carbon cycle models used for the verification of CO_2 emissions and Kyoto monitoring, and even more globally by the users of GEOSS (Global Earth Observation System of Systems).

SOCIO-ECONOMIC IMPACT

Historical partners and founders of IAGOS are Airbus, CNRS and Météo-France.

In France, industrial production of equipment (Package 1, measuring ozone and CO), transmission devices for real-time data (RTTU), and integration kits are subcontracted to regional private companies: LG M in Blagnac, Atmosphere in Toulouse and Sabena Technics in Bordeaux.

IAGOS has allowed keeping 1-3 jobs at Sabena Technics and LGM respectively.

DATA

Data flow: One IAGOS flight ~ 3 MB. Objective of 20 aircraft ~ 120 MB per day.

Data storage: IAGOS infrastructure is mainly supported by rcentral data base and network calculation: "Laboratoire d'Aérologie" . The data services from Observatoire Midi-Pyrénées and AERIS also support IAGOS data policy.

Accessibility: www.iagos.fr

Presence in data networks: WMO (GAW), Copernicus Atmosphere Monitoring Service (CAMS)

Construction costs
—
Total of 20 M€ including 28% of French contribution
Operating costs:
0.185 M€ in 2016

Personnel
—
10 FTE

International dimension

IAGOS ESFRI Landmark

Coordinator: Andreas Petzold, DE

Partner countries: DE, FR, UK

Website: www.iagos.org



Type: RI, AISBL

Headquarters location:
Toulouse

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Valérie THOURET

Construction:	Operation:
2011	2011

Maintenance:
Finalisation of the equipment of 20 aircrafts planned for 2025

Stakeholders in France:
CNRS, Météo-France

Contact in France:
valerie.thouret@aero.obs-mip.fr
valerie.thouret@iagos.org

www.iagos.fr

I-LICO

Seashore And Coastal Research Infrastructure



Type: RI

Headquarters location:
Brest

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Jérôme PAILLET

Construction:	Operation:
2016	2016

Stakeholders in France:
CNRS, IFREMER, IRD, SHOM/
Marine universities network

Contact in France:
jerome.paillet@ifremer.fr

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 understandings 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 observation needs therefore measurements, via sensors and collected samples, at the relevant spatial and frequency, to characterise the long-term evolution of marine coastal and littoral environments.

This monitoring will also promote the understanding and forecasting of some processes and the impact of extreme events. The RI, gathering 8 French observation systems (labelled or in the course of being labelled) 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.

SOCIO-ECONOMIC IMPACT

There is a strong interest of the French local and national authorities as well as many local partners for observations at regional level, such as the ecosystem health, coral reefs, sea water quality, coastal risks, climate changes.

DATA

Data flow: The data flow will be evaluated during the first years.

Data storage: Data and related services will be saved in interface with the Ocean Data pole of the RI "Pole de données".

Accessibility: The data will be interoperable and freely available to the scientific community through different portals of observation systems and ocean Data Pole.

Presence in data networks: CORIOLIS, SEDOO, French data centers: CYBER, PELAGOS, BENTHOS, SEADATANET, COPERNICUS, CMEMS, EMODNET

Personnel

90 FTE

OZCAR

Critical Zone Observatory, Research and Applications

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).

OZCAR is a research infrastructure essential for an enlarged and consolidated vision of environmental changes occurring on continental surfaces. It gatters research observatories of national research organisms as well as the Systems of long-term Observation and Experimentation for environmental REsearch (SOERE) labeled by AllEnvi. 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 the economic world.

The research infrastructure is focussed on:
- watersheds;
- dydrometeorology;
- aquifers...

SOCIO-ECONOMIC IMPACT

OZCAR interacts with stakeholders (public services and economy sectors such as competitiveness clusters and enterprises) who are concerned by water resources management, hydrological risk, soil quality and associated ecosystem services, rehabilitation of ecosystems, underground storage.... Innovative technologies will be developed: noninvasive geophysics, in-situ high-frequency measurements, sensors, systems of transmission, storage and processing of information.

DATA

Data flow: Several TB/year

Data storage: Databases and services: Theia Pole (under preparation)

Presence in data networks: Data are available from portal of LTER I3 H2020 project.

Operating costs
—
About 10 M€

Personnel
—
130 FTE

International dimension

ESFRI project "eLTER" continuing INFRAIA project "eLTER".

Coordinator: I. Kühn, M. Mirtl, DE

Partner countries: DE, AT, NL, UK, ES, IT, BE... (21 countries involved)

Website: www.lternet.edu



Type: RI

Headquarters location:
Paris

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Jérôme GAILLARDET

Construction:	Operation:
2016	2016

Stakeholders in France:
CNRS, INRA, IRSTEA, IRD, BRGM, ANDRA, IGP, Universities of Aix-Marseille, Antilles, Avignon, Brest, Caen-Rouen, Franche-Comté, Grenoble, La Réunion, Orléans, Poitiers, Montpellier, Paris-Est-Créteil, Paris-UPMC, Paris-Sud, Nancy, Rennes, Strasbourg, Toulouse

Contact in France:
gaillardet@ipgp.fr

RARE

Agronomic Resources for Research



Type: RI

Headquarters location:
Paris

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Michèle TIXIER-BOICHARD

Construction:	Operation:
2015	2016

Stakeholders in France:
INRA, CIRAD, CNRS, IRD

Contact in France:
contact@rare.eu

animal:
www.crb-anim.fr/Le-CRB-Anim

vegetal and microbial:
www.ibisa.net/

The main objective of RARe is to improve the national and European visibility of biological resources maintained by its constitutive BRC and to facilitate their use by a large research community, from agriculture research to life sciences and environmental sciences. At the European level, the only similar organization is the Center for Genetic Resources hosted by WUR.

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 RARe 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. The infrastructure supports interdisciplinary research and trans-sectorial scientific discussions for various fields of application.

The added value of RARe relies on sharing skills, harmonising practices, triggering projects in comparative biology, and proposing a single entry portal to facilitate access to documented samples, taking 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 I.P. issues.

RARe will provide an operational support to its members regarding the implementation of the Nagoya protocol and French biodiversity low, for access and benefit sharing regarding the use of genetic resources.

SOCIO-ECONOMIC IMPACT

Partners come from all sectors of agriculture: plant and animal productions, food industry, non-food use of biomass, environmental biotechnology. Each constitutive pillar of RARe has already an organised partnership with either agriculture sector, diagnostic and pharmaceutical sector, biotechnology or cryobiology industries. Some BRCs of RARe have a specific partnership with developing countries.

DATA

Data flow: 10 TB in 2015.

Data storage: local, within RARe.

Accessibility: Access is free for passport data regarding technical, reproductive and sanitary quality of the stored samples. Results from advanced characterization (phenotypic, molecular, environmental) are partially accessible depending on the pillar, either through metadata or through centralized information systems, with the submission of a request to local information systems of BRCs.

Presence in data networks: Genomic data can be found in DDBJ/ENA/GenBank. Phytogenetic resources are using the following international standards and information systems: (i), Multicrop Passport Data, ECPGR or IPGRI descriptors, taxonomy standards (ii) Crop Ontology (iii) data interoperability in the frame of international projects (WheatIS (http://wheatis.org/), DivSeek (http:// www.divseek.org/), Elixir-Excelerate (http://elixir-uk.org/excelerate).

International dimension

MIRRI (Microbial Resource Research Infrastructure), ESFRI Roadmap

Coordinator: Erko Stackebrandt, DE

Partner countries: UK, NL, ES, PL, PT, IT, BE, SE, RU, FR

Website: MIRRI www.mirri.org

RECOLNAT

French Naturalist Collections Network

RECOLNAT offers valuing 350 years herbarium, fossils and animals stuffed and conservated 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, databasing 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 come 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. Volonteers form networks of skills and expertise. A citizen science site already offers people to complete the herbarium label from images.

SOCIO-ECONOMIC IMPACT

Industrial digitization RECOLNAT uses Picturae. The herbarium restoration was developed by GRAHAL.

Agoralogie, CNAM and MNHN: citizen science site Les Herbonautes totaled 1.5 million in contributions. In 2016, a call for projects will allow researchers to obtain scientific data from images. Through the GBIF, the site is cloned in Portugal and Germany.

DATA

Data storage: Several TB

Accessibility: Free access for single images. As a service charged in case of multiple consultations.

Presence in data networks: ECOSCOPE, INPN, GBIF



Type: RI

Headquarters location:
Paris

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Marc PIGNAL

Construction:	Operation:
2013	2018

Stakeholders in France:
MNHN, Univ. Montpellier, Univ. Bourgogne, Univ. Clermont-Ferrand, IRD, CNAM, INRA, Tela Botanica, Agoralogie

Contact in France:
contact@recolnat.org

recolnat.org

RESIF/EPOS

French seismic and geodetic network / European Plate Observing System



Type: RI

Headquarters location:
Paris

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Stéphane MAZZOTTI

Construction:

2011

Stakeholders in France:
CNRS, BRGM, CEA, CNES, IFREMER, IFSTTAR, IGN, IPGP, IRD, IRSN, OCA, Univ. Clermont Ferrand, Univ. Grenoble, Univ. Montpellier, Univ. Strasbourg, Univ. Nantes, Univ. Nice Sophia Antipolis, Univ. Toulouse

Contact in France:
contact@resif.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. All of 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 Boundary) and coordinates EPOS activities in France. EPOS is in implementation phase (2015-2019), during which EPOS-ERIC will be established.

SOCIO-ECONOMIC IMPACT

RESIF/EPOS distributes data necessary to create downstream products, which are produced by members of the RESIF/EPOS Consortium. Some of these products are contributing to the decision making process by the national or local authorities in the area of seismic hazard and natural resources. Finally, RESIF works in partnership with a French startup which develops a new type of absolute gravimeter.

DATA

Data flow: Approximately 20 TB/year

Data storage: Distributed storage and distribution

Accessibility: Data freely available.

Presence in data networks: FDSN, EIDA, BGI, GGP.

Construction costs

10 M€
Operating costs: 1.1 M€

Personnel

40 FTE

International dimension

EPOS, ESFRI Roadmap

Coordinator: Massimo Cocco, IT

Partner countries: CZ, DK, FR, DE, GR, IS, IE, IT, NL, NO, PL, PT, RO, ES, SE, CH, TR, UK

Website: www.epos-eu.org

SAFIRE

French Airborne Environment Research Service

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

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

The 3 airplanes have many specific emplacements for any equipment or instruments. The SAFIRE expertise is dedicated 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.

SOCIO-ECONOMIC IMPACT

Cooperation with French aerospace industry (SMEs and large groups) and support to space domain (Earth observation, calibration/validation of new onboard instruments for satellite missions) allows SAFIRE to reinforce the strengths in those areas of activity at global level. SAFIRE may also play a role in the development of regional centers on activities such as the use of Unmanned Aerial Vehicle.

DATA

Data flow: About 2 GB/year of data

Data storage: About 7 TB of data

Accessibility: Atmospheric data center AERIS. Access free for unit inquiries. Payed services for multiple consultations.

Presence in data networks: Atmospheric data center (AERIS).

Construction costs

25 M€

Operating costs: 1.7 M€

Personnel

23 FTE

International dimension

EUFAR (European Fleet for Airborne Research)

Coordinator: Phil Brown, UK

Partner countries: DE, CZ, IT, FR, ES, UK, AT, IL, CH, PL, BE

Website: www.eufar.net



Type: RI

Headquarters location:
Cugnaux

Head of the Infrastructure:
Aurélien BOURDON

Construction:	Operation:
2005	2006

Maintenance:
Purchase and equipment of a new aircraft in the period of 2018-2020

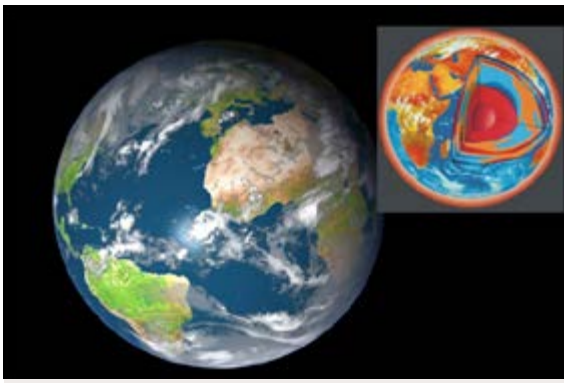
Stakeholders in France:
CNES, CNRS, Météo-France

Contact in France:
desk@safire.fr

www.safire.fr

PÔLE DE DONNEES

Data and Services Center for Earth System Modelling



Type: Project

Headquarters location:
Paris

Other sites:
Virtual research infrastructure

Head of the Infrastructure:
Nicole Papineau (AERIS), Michel Diament (Form@Terre), Nicolas Baghdadi (THEIA), Fabienne Gaillard (OCEAN)

Construction:	Operation:
2016	2017

Stakeholders in France:
CNES, CNRS, Ifremer, IRD, IRSTEA, Météo France, SHOM, BRGM, CEA, CEREMA, CIRAD, IGN, INERIS, INRA, IPGP, ONERA, OCA, Observatoire de Paris, Ecole Polytechnique, Marine universities network, Univ. Lille 1, Univ. Toulouse, Univ. Pierre et Marie Curie/ Hauts de France Region

Contact in France:
nicole.papineau@ipsl.jussieu.fr
diament@ipgp.fr
nicolas.baghdadi@teledetection.fr
fabienne.gaillard@ifremer.fr

In order to answer the main questions that society has on the history, functioning and evolution of our planet as well as on its environment, scientific research must consider the earth system as a whole, and take into account how the different compartments interact.

The IR offers access to data, products and services relative to the observation of the earth system. Meant to serve primarily the French research community, those products have international aims (satellite missions, global observing networks, partnership for development).

The IR products are defined and elaborated under the guidance of experts to ensure that they agree with the highest scientific and technical standards. Data series and products from observing networks, in-situ campaigns and satellite missions, will be qualified, described and interoperable. The IR will also create its own products.

Tools for data discovery, visualisation, extraction and processing, as well as computing resources, will be made available to facilitate the use of the IR information.

To encourage the sharing of information, good practices and contribute to the scientific and technical education and training of the user communitythe IR will develop collaborative platforms.

SOCIO-ECONOMIC IMPACT

Information and data distributed by the IR are important for the implementation of public policies. Works using these datashave socio-economic impact on domains such as: natural hazards, climate change, natural resources.

The data centres contributing to the IR are spread over different regions where they contribute to the development of SME specialized in the processing and use of their data.

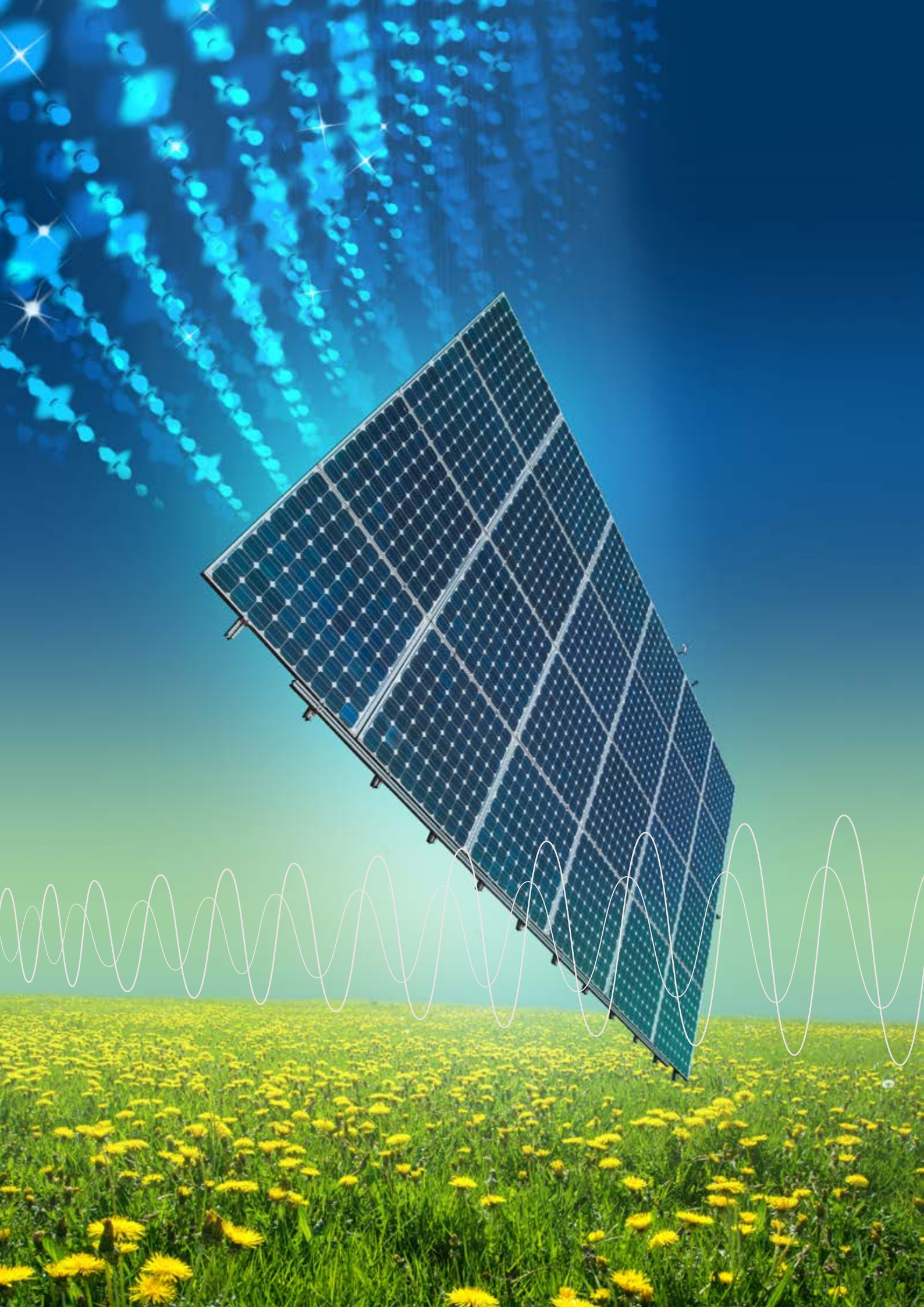
DATA

Data flow: From a few KB to several PB

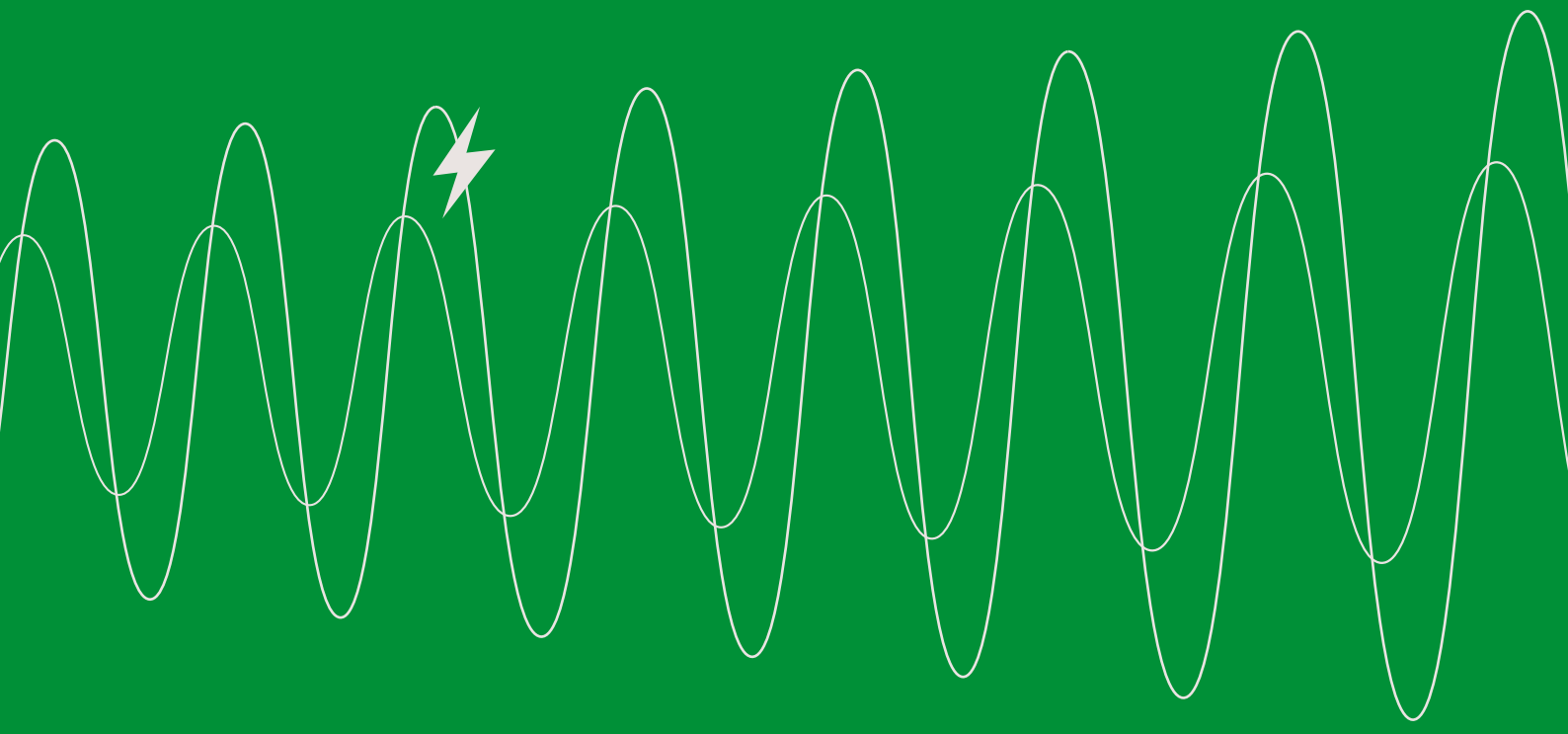
Data storage: IR data centers

Accessibility: Web, FTP

Presence in data networks: RESIF, EPOS, EURO-ARGO, EMSO, ICOS, IAGOS, ACTRIS, EUFAR, EmodNet, Copernicus and several global networks contributing to GEOSS



ENERGY



Energy

GLOBAL CONTEXT

The perspectives for a sustainable and economically viable development are entirely dependent on a sustainable supply of energy, secured with a reduced impact on the environment, on a local scale as well as a global scale. In addition, the energy problem is part of a complex framework that meet satisfy 4 major challenges: guarantee access to energy for populations, prevent energy precariousness, participate in global warming control, offer a sustainable energy mix. As such, the world of energy has to meet the increase in demand, recall that about 60% of the growth in demand is expected between 2000 and 2030, via a wide diversification in the sources of energy, via increasing the production of non-fossil fuels along with the penetration of variable energies, in particular for controlling greenhouse gas emissions. In order to meet the needs of the diversification in supply and the major climate challenges, the 21st century will therefore be the century of energy transition and France has in particular availed itself of a law for energy transition for green growth. Controlling the energy mix by 2050 is therefore a major challenge with international proportions which leads to substantial needs for research and specific equipment.

THE MAIN CHALLENGES FOR PROGRESS AND THE ASSOCIATED MAJOR INFRASTRUCTURES

The future global energy mix requires deploying alternative solutions as quickly as possible: biomass, waste reclamation, thermodynamic or photovoltaic solar energy, land or offshore wind energy, marine energies, in particular hydrokinetic, hydraulics, geothermal energy, but also developing new-generation nuclear and techniques for reducing the carbon footprint for the production of thermal electricity via Capture, transport, storage and valorisation techniques for CO_2 (VCCS). A substantial deposit exists but regardless of the form, these solutions require major investments, a lot of R&D work with a strong need for dedicated research infrastructures. In collaboration with the Alliance ANCRE, work on analysing the French deposit of infrastructures was conducted and 5 were put forth as the most representatives of future needs. To date, these infrastructures have variable levels of maturity and organisation which lead them to filing for either the status of an Infrastructure or that of a project.

Large-scale deployment of variable renewable energies requires recourse to new facilities with better performance and/or which are more competitive, and these are not yet available or are only at the prototype stage. Substantial research efforts, based on state-of-the-art experimental means and up to the pilot scale are as such required.
The challenges which are privileged for the years to come will cover:

- solar energy, with
  - **FR SOLARIS**, the French node of the Eu Solaris infrastructure "European SOLAR Research Infrastructure for Concentrating Solar power – listed on the ESFRI roadmap), which will be based on the solar facilities of Odeillo/Thémis for thermodynamic solar;
  - **SOPHIRA** which will offer first-rate experimental potential for photovoltaic solar by using what has been acquired from the European project SOPHIA and on the potential of the National Solar Energy Institute (INES) will appear as a project;
- marine energies:
  - **THEOREM**: Energies from the sea (currents, tides, swells, thermal energy) represent an enormous potential that is hardly used but is very difficult to domesticate. Those most in line in the middle term are hydrokinetic and tidal energy. In the longer term, wave energy conversion and thermal energy may appear. Today, little equipment is available to support these developments. **THEOREM** will offer this potential. It will be based on the national equipment of the Ecole Centrale de Nantes and of Ifremer. This is also the French node for the European ESFRI project Marinerg-i. THEOREM will appear as a project.

Nuclear energy will significantly contribute to the French electric mix in a short – middle – long term future, with third generation reactors (EPR) under construction and those of the fourth generation expected for 2040-2050. Research further upstream for the development of nuclear fusion are also in progress and the creation of a technological demonstrator (DEMO after ITER) will further require several decades. Offering experimental ways that result in improving the knowledge in the field of nuclear fusion is of great importance. Major infrastructures are part of this need and are highly involved in the international research consortia. They are:

- **WEST (Tungsten (W) Environment in Steady-state**. It develops the Tore Supra tokamak (built and operated under the auspices of the EURATOM-CEA Association in the 1980s) as direct support for ITER with regards to ITER, although managed in specific frameworks, it must be mentioned for its importance. Indeed, it must show the control of fusion energy via magnetic confinement and allow for the development over time of a new energy source and support industrial application. In the framework of international cooperation, ITER is currently under construction in France, on the Cadarache site and Europe is contributing a large portion of the project. In addition, there is a Euratom Fusion research programme in the framework of the Horizon 2020 programme, intended to coordinate the research activities of member states, of which one section concerns the materials and DEMO, the step that will follow ITER.

Finally, the contribution to the production of electricity via fossil resources will here too support the energy and ecological transition. However, the capture, transport, storage and valorisation of CO_2 will be inescapable. An infrastructure is dedicated to this problem. It is:

- **ECCSEL** (European Carbon dioxide Capture and Storage Laboratory) which is deployed on a European level and which will be listed on the ESFRI roadmap. This is a distributed infrastructure with BRGM as the French node and pilot. ECSSEL will appear as a project.

LIST OF RESEARCH INFRASTRUCTURES ENERGY

TYPE	NAME	FULL NAME	ESFRI
RI	FR-SOLARIS	Solar Thermal Research Infrastructure for Concentrated Solar Power	EU-SOLARIS (2010)
RI	WEST	W(Tungsten) Environment for Steady-state Tokamaks	
Project	ECCSEL-FR	European Carbon Dioxide Capture and StoragE Laboratory Infrastructure	ECCSEL (2008)
Project	SOPHIRA	SOlar PHotovoltaic Research Infrastructure	
Project	Theorem	Testing facilities for Hydrodynamics and Marine Renewable Energy	Marinerg-i (2016)

FR-SOLARIS

Solar Thermal Research Infrastructure for Concentrated Solar Power



Type: RI

Headquarters location:
Font-Romeu, Targassone

Head of the Infrastructure:
Gilles FLAMANT

Solar furnaces construction:	Operation:	Upgrade:
1959	1972	2015-2016

Thémis construction:	Operation:
1979	1983

Parabolic cylindrical mini power station construction:	Operation:
2015	2016

Stakeholders in France:
CNRS

Contact in France:
gilles.flamant@promes.cnrs.fr

www.equipex-socrate.fr

FR-Solaris missions are:
- to contribute to the development of knowledge in the field of:
  - Photophysics (ex: concentrating PV conversion);
  - Photochimistry (ex: photocatalysis);
  - Thermochimistry (ex: synthetic fuel production);
  - Thermal sciences (in particular radiative heat transfer);
  - Nanomaterials (ex: nanopowders elaboration);
  - Metallurgy (surface treatment, sintering ...);
  - Ceramic materials (space applications...);
- to improve concentrating solar thermal energy conversion and storage technologies;
- to define methodologies and procedures for solar components qualification.

The FR-Solaris research infrastructure is composed today of 5 sets of equipment:
- one 1 MW solar furnace (MWSF) and its dedicated equipment;
- 11 small and medium scale (1-6 kW) solar furnaces (MSSFs) and associated testing devices;
- one 50 kW parabolic concentrator;
- one 150 kWth and 15 kWel PT mini-power plant;
- one 5 MW solar tower.

Proposed services are the access to small scale solar furnaces (1 kW) for public research teams, high temperature tests and measurements (up to 3,000°C), preparation and realization of collaborative projects, assistance for testing new instrumentation in concentrating solar environment, qualification of solar components, ageing of materials under various solar irradiation.

SOCIO-ECONOMIC IMPACT

Partnership with French industries: EDF, CNIM, SNECMA, Arkema, Enogia, ADF ... and with European industry via FP7 et H2020.

Languedoc-Roussillon regional council selected the topic «concentrating solar and high efficiency solar energy conversion» as one of the priorities of 3S initiative.

The "Pyrénées Orientales" Council has created the promotion structure "Themis Solaire Innovation (TSI)" at Themis site.

Operating costs
—
0.110 M€

Personnel
—
9 FTE

International dimension

EU-Solaris (the European Solar Research Infrastructure for Concentrated Solar Power), ESFRI Roadmap

Coordinator: ES

Partner countries: ES, DE, FR, IT, EL, PT, TR

Website: www.eusolaris.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 action 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 € 24.8M 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.

SOCIO-ECONOMIC IMPACT

WEST federates the regional and French scientific and technical forces (academic, research, industry and education) in its field, offering them a unique springboard to the use of ITER.

Jobs and contracts generated by fusion are critical for the economic development of the Val de Durance, and WEST irrigates throughout the industrial network of the region.

Operating costs

300 M€

Operating costs: 15 M€

Personnel

100 FTE

International dimension

WEST is the French note in the european network (H2020/EUROfusion) and the international network (ITER agreement) of fusion infrastructures.

Coordinator: CEA, FR

Partner countries: FR, DE, JP, IN, CN, KR, CZ, PL, UE

Website: west.cea.fr



Type: RI

Headquarters location:
Cadarache

Head of the Infrastructure:
Alain BÉCOULET

Construction:	Operation:
2013	2016

Upgrade:
Phase 1: 2016-2018, phase 2: 2019

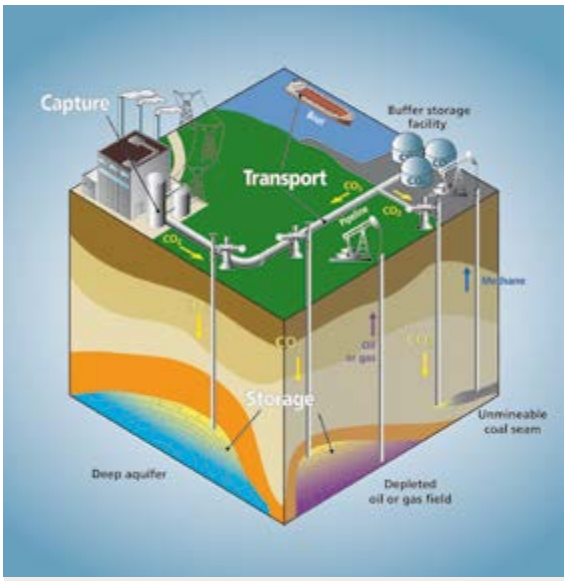
Stakeholders in France:
CEA

Contact in France:
alain.becoulet@cea.fr

west.cea.fr

ECCSEL

European Carbon Dioxide Capture and StoragE Laboratory Infrastructure



Type: Project

Headquarters location:
Orléans

Other sites:
Bure, Catenoy, Le Havre, Mont-la-Ville, Orléans, Rustrel, one facility in progress in Lacq

Head of the Infrastructure:
Isabelle CZERNICHOWSKI-LAURIOL

Construction:	Operation:
2008	2016

Stakeholders in France:
BRGM, Andra, CNRS, EDF, INERIS, TOTAL

Contact in France:
i.czernichowski@brgm.fr

To accelerate the development of carbon capture and storage and allow deployment in Europe and the world, we must intensify R&D efforts to reduce the costs of the various technological links and ensure their efficiency and safety. The ECCSEL infrastructure will offer sites and state-of-the-art experimental benches to allow to European researchers and engineers to develop and test new tools, methods and processes across the entire value chain: capture, transport and geological storage of CO_2, by opening also the way to options of valuation of the CO_2. It will coordinate and structure the European efforts on access to research facilities and infrastructure investments, thereby streamlining efforts and costs and strengthening the international position of European research.

ECCSEL-FR brings together all the French research facilities that are under coordination to ensure France's presence in the ECCSEL European infrastructure:

- CO_2 Storage:
  - BIOREP - BIO-Reactor for Deep Environments (BRGM), Orléans;
  - LSBB - Low-Noise Underground Laboratory (CNRS), Rustrel;
  - LS-Andra - Meuse/Haute-Marne Underground Laboratory (Andra), Bure;
  - Catenoy Site in Oise (INERIS), Catenoy;
- CO_2 Transport:
  - Mont-la-Ville Site in Oise (INERIS), Mont la Ville;
  - COOTRANS Transport Loop (TOTAL), Lacq – design stage;
- CO_2 Capture:
  - CO_2 Capture Pilot (EDF), Le Havre.

SOCIO-ECONOMIC IMPACT

ECCSEL may forge partnerships with various private and public actors in research and innovation.

In France they are brought together in the following structures: Club CO_2, GIS GEODENERGIES, ANCRE and AllEnvi alliances, and the competitiveness clusters AVENIA, TRIMATEC, RISQUES, ÉA éco-entreprises/GREEN, OPTITEC, AXELERA, CAPENERGIES, TENERRDIS...

Operating costs
—
0.4 M€

Personnel
—
13 FTE

International dimension

ECSSEL AS, ESFRI Roadmap

Coordinator: NO

Partner countries: NO, UK, NL, FR, IT, PL, ES, EL, CH

Website: www.eccsel.org

SOPHIRA

SOlar PHotovoltaic Research Infrastructure

Solar photovoltaic is extremely diversified, both by materials and used processes, and by the systems and allowed applications. A coordination of the research infrastructures at the national and European levels is thus necessary to allow a better efficiency of the national research budgets.

SOPHIRA aims to become the French node of a European infrastructure.

Equipment used or implemented to reach these objectives will be of several natures:

1. clean room laboratories, equipment, process and advanced characterization tools (TRL2 to 4);
2. pilot lines, in order to validate some processes and methods of in-line characterization, to insure the extrapolation towards industrial capacities;
3. test-benches and multiple demonstrators, with experience feedback via a e-infrastructure, to allow the development of the software of supervision, management, and maintenance.

Scientific scope:

1. Scientific fields covered by the infrastructure:
   - processes and characterization of materials, cells, and photovoltaic solar modules;
   - modelling and development of components and systems;
   - modelling of large-scale integration in energy systems;
2. Missions and services:
   - material validation;
   - realization and validation of architecture of cells and modules;
   - development of new processes;
   - automated large-scale performance analysis of modules and systems.

SOCIO-ECONOMIC IMPACT

This infrastructure will be based on several existing facilities to which some new and innovative facilities covering the whole value chain:

1. upstream, material producers, equipment suppliers, cell and module manufacturers;
2. downstream, all stakeholders involved in large-scale integration of solar in grids, buildings, cities and mobility.

Construction costs
—
10 M€



Type: Project

Headquarters location:
Le Bourget-du-Lac

Head of the Infrastructure:
Philippe MALBRANCHE

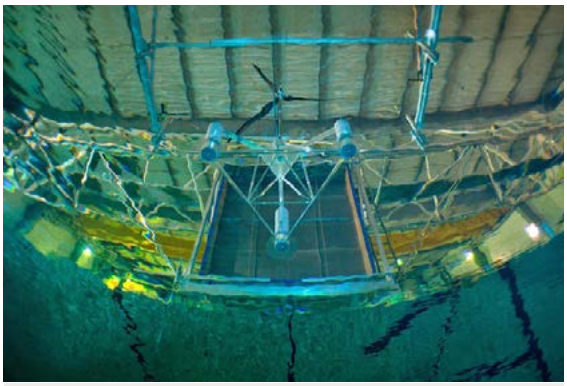
Stakeholders in France:
CEA

Contact in France:
philippe.malbranche@cea.fr

www.sophia-ri.eu

THEOREM

Testing facilities for Hydrodynamics and Marine Renewable Energy



Type: Project

Headquarters location:
Nantes, Brest

Other sites:
Boulogne-sur-Mer, Le Croisic

Head of the Infrastructure:
Pierre FERRAND, Jean-Marc DANIEL

Construction:	Operation:	Maintenance:
2015	2016	2016-2020

Stakeholders in France:
École Centrale Nantes, IFREMER

Contact in France:
pierre.ferrant@ec-nantes.fr
jean.marc.daniel@ifremer.fr

wwz.ifremer.fr/rd_technologiques/Moyens/Moyens-d-essais/Bassin-d-essais-du-centre-de-Bretagne

lheea.ec-nantes.fr/doku.php/expe

www.semrev.fr

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

- The Ecole 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 pool 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);
- And Ifremer:
  - Ocean Engineering Pool (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 a seawater filling;
  - Wave and Currant Flume (Boulogne-sur-Mer): in 1990, Ifremer acquired a circulation stream, unique facility in France and Europe, dedicated to the study of the behavior of underwater devices. Equipped in 2010 of a wave generator for the consideration of wave-current interaction.

SOCIO-ECONOMIC IMPACT

The rising of a MRE industrial chain (engineering, services, devices production and assembly, marine operations, maintenance companies) is a promising development support at a regional scale as well as at a national and European level. The Infrastructure contributes to the development of this sector through numerous joint research projects with the industrial sector.

DATA

Presence in data networks: Eurocean Marine Research Infrastructures Database (rid.eurocean.org)

Construction costs
—
62 M€
Operating costs: 1.2 M€

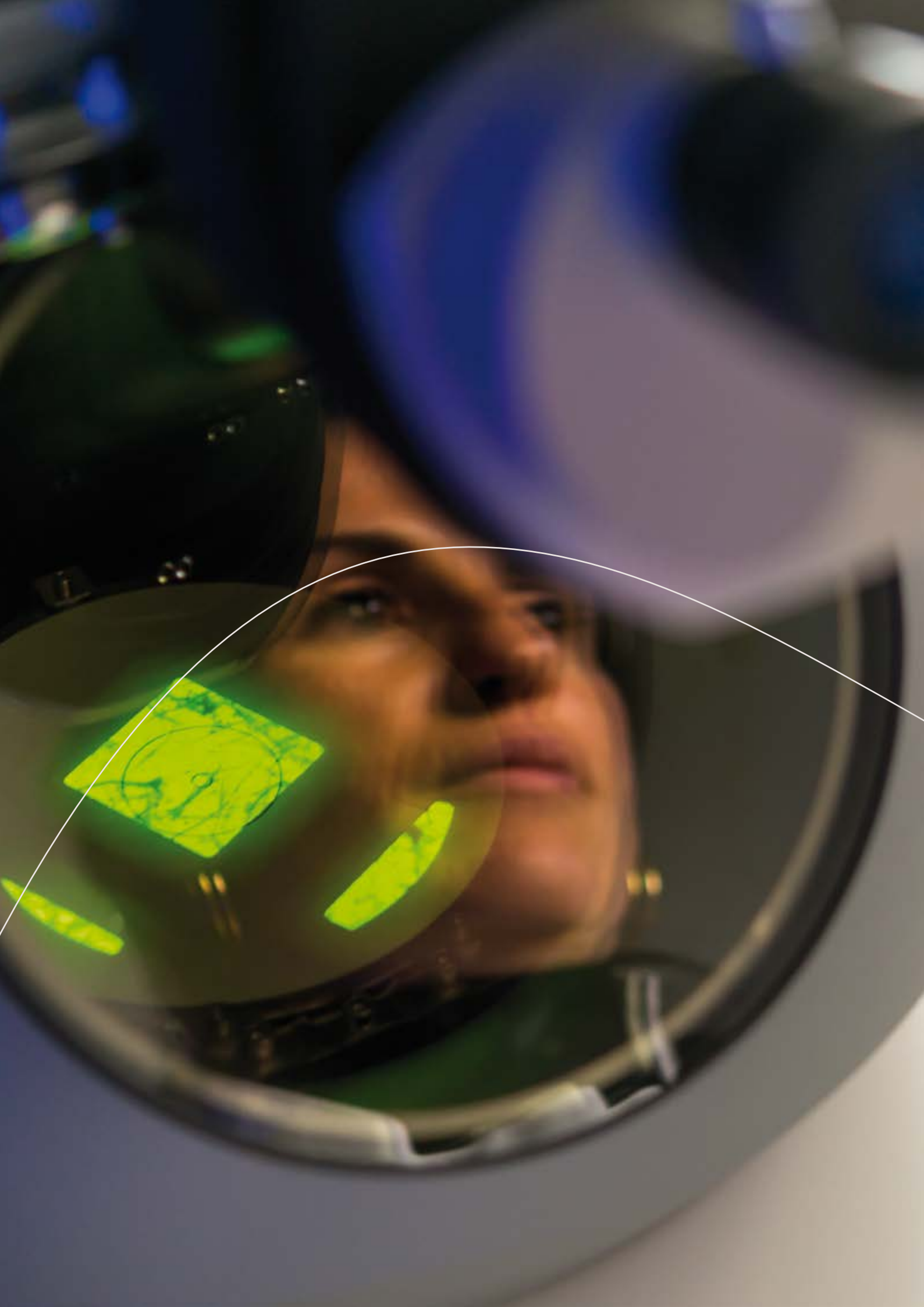
Personnel
—
30 FTE

International dimension

Under construction, will be French node for the european infrastructure Marinerg-i

Coordinator: UCC-MaREI, IE

Partner countries: IE, PT, ES, UK, FR



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, in particular genomic sequencing which has initiated the era of high-speed biology and high-resolution imaging, has revolutionised the approaches for exploring living organisms.

The technologies needed, 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, consecrating the success of a long structuring policy in the 1990s. In 2010 and 2011, calls for tender for national infrastructures and pre-industrial demonstrators were launched in the framework of the Biology and Health programme of the Investments for the Future Programme (PIA), in order to develop the technological infrastructures needed to maintain research excellence in the field of life sciences. The research infrastructures presented here have all been identified in this framework. Some of these national infrastructures are the French components of the ESFRI European infrastructures, and as such contribute to our international scientific visibility and to the construction of the European research area.

Mostly connected with Aviesan, some of them also concern joint fields of interest with AllEnvi, such as the Network of Biological Resource Centres for animals (CRB Anim) which is part of the RARe Infrastructure (Agronomic resources for research), presented in the environment sheet. Some of the infrastructures listed under the Material Sciences and Engineering heading (synchrotron radiation centers, high field NMR network...) are used by biologists.

The Biology and Health research infrastructures share certain specificities as often being distributed over several geographical sites (but with a centralised access procedure) and being of modest size compared to most single-site VLRIs of this roadmap. They nevertheless form units that can sometimes exceed 100 FTE. They receive strong support from lead and partner institutions. Securing their future is still a challenge that must be met for the benefit of scientific communities that can take through them advantage of competitive high technology services.

France is a member of two international organisations in the field of biology:

- EMBL which, with six research sites, is one of the major centres of excellence for fundamental biology research in the world;
- the EMBC which provides a framework for European cooperation in the field of molecular biology and supports efforts concerning training, teaching and research and offers scholarships.

On a national level, the infrastructures in the "Biology and Health" perimeter are organised here into 4 thematic groups:

I. the **functional exploration 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 organism and biological resources** make available the biological models and samples required for studying living organisms. Analysis 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 make it possible to provide the community pluripotent stem cells of clinical grade and collections of human and microbial biological resources.

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 synthesis chemistry.

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 is increasing exponentially. The French Institute of Bioinformatics has the ambition of coordinating 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 with data for the monitoring of health indicators and the distribution of the main determinants of health at the general population level.

As the landscape of Biology and Health infrastructures is constantly changing, the improvement of existing infrastructures and the rapid deployment of new technologies are a first priority. There clearly exist **emerging infrastructures** in several technological fields (Screening and chemical libraries, Cognitive neurosciences, Cohorts, Databases for health research…), which are expected to be listed in the next revision of the roadmap. A portion has moreover received support from the PIA in the Cohorts or Equipex programmes and the design of a health data infrastructure stems from the recent law of modernisation of our health system.

LIST OF RESEARCH INFRASTRUCTURES BIOLOGY AND HEALTH

TYPE	NAME	FULL NAME	ESFRI
INTERNATIONAL ORGANISATIONS			
IO	EMBL	European Molecular Biology Laboratory	
IO	EMBC	European Molecular Biology Conference	
FUNCTIONAL EXPLORATION			
RI	FBI	France-BioImaging	EUBIO (2008)
RI	FLI	France Life Imaging	EUBIO (2008)
RI	France Génomique	French national genomics and bioinformatics infrastructure	
RI	FRISBI	French Infrastructure for Integrated Structural Biology	INSTRUCT (2006)
RI	MétaboHub	The French national infrastructure for metabolomics and fluxomics	
RI	PROFI	Proteomics French Infrastructure	
MODEL ORGANISM AND BIOLOGICAL RESOURCES			
RI	BIOBANQUES	Biobanks national infrastructure	BBMRI (2006) + MIRRI (2010)
RI	CELPHEDIA/ PHENOMIN	French national infrastructure in mouse phenogenomics	INFRAFONTIER (2006)
RI	CELPHEDIA/TEFOR	Transgenesis for functional studies in model organisms	
RI	CRB Anim	Biological Resource Centers for domestic animals	
RI	*EMBRC-France*[1]	*National Marine Biological Resource Center*	*EMBRC (2008)*
RI	*EMPHASIS France*[2]	*European Multi-environment Plant pHenomics And Simulation InfraStructure*	
RI	INGESTEM	National Infrastructure for pluripotent stem cells and tissue engineering	
Project	*IBISBA-FR*[3]	*Industrial Biotechnology Innovation and Synthetic Biology Accelerator*	

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".

TYPE	NAME	FULL NAME	ESFRI
PRECLINICAL AND CLINICAL INVESTIGATION			
RI	E-CellFrance	French Network Infrastructure for mesenchymal stem cell (MSC)-based therapies	
RI	F-CRIN	French Clinical Research Infrastructure Network	ECRIN (2006)
RI	Fr-Hadron	France HADRON	
RI	HIDDEN	Highly Infectious Diseases Dedicated Infrastructure ExtensioN	ERHINA (2008)
RI	IDMIT	Infectious Deseases Models for Innovative Therapies	
RI	NEURATRIS	Translational research infrastructure for innovative therapies in Neuroscience	EATRIS (2006)
RI	PGT	Pre Industrial Geno Therapy Consortium	
BIOINFORMATICS, COHORTS AND DATABASES			
RI	CONSTANCES	Population-based epidemiological cohorte	
RI	IFB	French Institute of Bioinformatics	ELIXIR (2006)

EMBL

European Molecular Biology Laboratory



Type: International Organisation

Headquarters location:
Heidelberg, DE

Other sites:
Hambourg (DE), Grenoble (FR), Monterotondo (IT), Hinxton (UK), Barcelone (ES)

Contact persons in France:
Anne PAOLETTI, Elena HOFFERT

Construction:

1974

Stakeholders in France:
MENESR

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 priorities are elaborated by a scientific committee and endorsed by the General Assembly. The strategic priority of EMBL for the 2017-2021 period is the digital biology. A CEO provides the scientific management of the EMBL with program coordinators and directors of antennas.

One hundred young scientists from the Member States, selected on their previous scientific achievements, have supervisory responsibilities (group leaders). 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. After having established international visibility, the group leaders usually leave EMBL after 4-5 years and develop an independent research activity. EMBL develops a 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).

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).

Operating costs

—

200 M€
including 16.6 M€ of French contribution

International dimension

Coordinator: Iain Mattaj, Director General

Partner countries: 22member states: AT, CH, DE, DK, FR, IL, IT, NL, SE, UK, FI, EL, NO, ES, BE, PT, IE, IS, HR, LU, CZ, MT and 2 associate members: AR and AU

EMBC

European Molecular Biology Conference

The EMBC provides, through its General Program, a framework for European co-operation in the field of molecular biology and closely related research areas.

The General Program focuses primarily on the provision of training, teaching and research scholarships and on the establishment of programmed for courses, workshops and study meetings.

The execution of the EMBC General Program is entrusted to EMBO. Both EMBC and EMBO are driven by a common commitment to quality research at the European level. Their joint activities are characterized by quality and encouragement of co-operation within the scientific community.

EMBC is led by a President, two Vice Presidents and a Secretary General. EMBC Delegates are nominated by the governments of the member states.

The elements of the EMBC General Program include:
- EMBO Fellowship Program;
- EMBO Courses and Workshops Program;
- EMBO Young Investigator Program;
- EMBO Science Policy Program.

Additional activities include:
- EMBO|EMBL Symposia;
- Career Development;
- The EMBO Meeting;
- EMBO Global Exchange;
- EMBO Women in Science;
- EMBC Special Project: Strategic Development Installation Grants (SDIG);
- EMBO Scientific Publications.

SOCIO-ECONOMIC IMPACT

EMBO is a not-for-profit organization but, by providing various forms of training, it fully contributes to knowledge-based economy in Europe and the rest of the world.

Operating costs

2015: 19 M€
including 2.9M€ of French contribution

International dimension

27 member states: AT, BE, HR, CZ, DK, EE, FI, FR, DE, EL, HU, IS, IE, IL, IT, LU, NL, NO, PL, PT, SK, SI, ES, SE, CH, TR, UK

Coordinator: Gerrit van Meer, NL



Type: International Organisation

Headquarters location:
Heidelberg, DE

Contact person in France:
Anne PAOLETTI, Elena HOFFERT

Construction:

1969

Stakeholders in France:
MENESR

Contact in France:
anne.paoletti@recherche.gouv.fr
elena.hoffert@recherche.gouv.fr

embc.embo.org

BIOBANQUES

Biobanks national infrastructure



Type: RI

Headquarters location:
Paris, FR

Other sites:
94 centers of biological ressources

Head of the Infrastructure:
Georges DAGHER

Construction:	Operation:
2011	2014

Stakeholders in France:
Inserm, INRA, Institut Pasteur, CEA, CNRS, CNCR

Contact in France:
biobanques@inserm.fr

www.biobanques.eu

BIOBANQUES is a distributed infrastructure based on a landscape of 94 biobanks. It covers the whole spectrum of human diseases with more than 700 ongoing biological and clinical research programs. It aims to:
- foster translational research and development of biomarkers;
- support and expand multidisciplinary platforms by mutualizing expertise and know-how;
- improve public-private partnership.

To this end, the infrastructure favors:
- development of national and international consortia;
- exchange of biological resources and associated data;
- access to resources via a single procedure;
- samples quality control;
- interoperability of clinical and biological databases.

SOCIO-ECONOMIC IMPACT

Biobanques contributed to the development of innovative technologies:
- the storage of DNA at room temperature under neutral gas;
- sample traceability by means of RFID.

For 2016-2017 it plans to develop the storage of RNA at room temperature under neutral gas, the robotiszation of sample processing, software developments for precision medicine.

International dimension

Biobanking and Biomolecular research Infrastructure (BBMRI-ERIC), ESFRI Landmark

Microbial Resources Research Infrastructure (MIRRI), ESFRO roadmap

Coordinateurs:
BBMRI-ERIC: Jan-Eric Litton
MIRRI: Erko Stackebrandt

Partner countries:
BBMRI-ERIC: 19 countries of EU
MIRRI: 19 countries of EU

Website:
www.bbmri-eric.eu
www.mirri.org

CELPHEDIA/PHENOMIN

French national infrastructure in mouse phenogenomics

The complexity of the relationship between the genome and the environment, with the adaptation of the phenotype of an individual as direct consequence, led to the development of PHENOMIN, an infrastructure dedicated to the scientific community in order to:

1. increase the knowledge of mammalian genome by studying gene function in integrated processes (development, physiology and behavior, aging, inflammatory response....) and the function of unannotated genes or non-coding regions (96% of the genome);
2. identify and understand changes in the genome or pathogenic mutations responsible for diseases. This includes the analysis of single and multigenic contribution, of the role of point mutations, rare alleles, or copy number variants (CNVs, Down syndrome, microdeletion syndromes...);
3. discover new opportunities for innovation and the development of therapies or molecules to meet societal demand (anti-tumoral immunotherapies...).

These key objectives are pursued with the establishment of a high level of sharing and integration through a single access portal; actions of training and joint communication to strengthen national and international visibility; and with an offer based on high added value services for the creation, breeding, preservation, functional analysis and multivariate testing, evaluation of new therapies, open to private and academic partners; all in compliance with the rules of ethics and the animal welfare.

SOCIO-ECONOMIC IMPACT

About 10% of the activity of PHENOMIN is performed for private partners. Moreover PHENOMIN works with ten industrial partners for research and development in the areas of new therapies against urogenital diseases, cancer, rare diseases, innovative tools for breeding, microscopy or prototypes of devices and strategies for in vivo imaging.

DATA

Presence in data networks: International Mouse Phenotyping Consortium INFRAFRONTIER

Construction costs
—
65 M€
Operating costs: 14 M€

Personnel
—
109.6 FTE

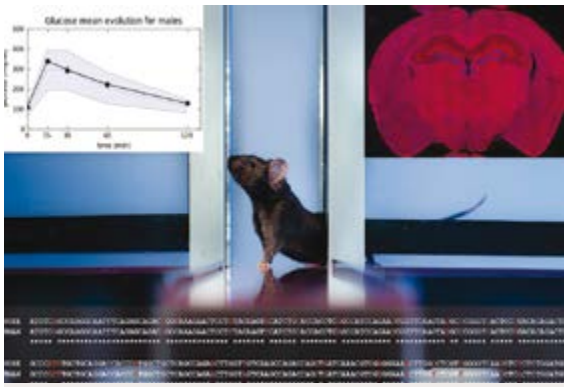
International dimension

Founder of INFRAFRONTIER, ESFRI Landmark
Founder of International Mouse Phenotyping consortium (IMPC)

Coordinator:
INFRAFRONTIER: Martin Hrabé de Angeli
IMPC: Mark Moore

Partner countries:
INFRAFRONTIER: DE, FR, CZ, FI, EL
IMPC: UK, FR, DE, IT, ES, CZ, JP, KR, CN, AU, USA, CA, EMBL

Website:
www.infrafrontier.eu/www.mousephenotype.org



Type: RI

Headquarters location:
Illkirch, FR

Other sites:
Marseille, Luminy, Orléans, Villejuif

Head of the Infrastructure:
Yann HERAULT

Construction:	Operation:	Maintenance:
2011	2011	2018

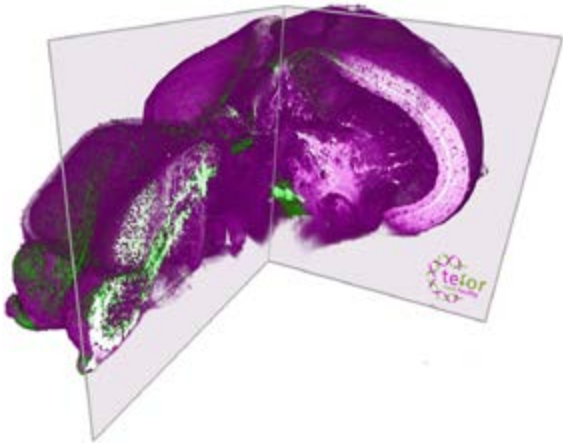
Stakeholders in France:
CNRS, INSERM, Univ. Strasbourg, AMU, CERBM-GIE

Contact in France:
herault@igbmc.fr
contact@phenomin.fr

www.phenomin.fr

CELPHEDIA/TEFOR

Transgenesis for functional studies in model organisms



Type: RI

Headquarters location:
Gif-sur-Yvette, FR

Other sites:
Paris, Jouy-en-Josas, Versailles, Rennes, Nantes, Clermont-Ferrand

Head of the Infrastructure:
Jean-Stéphane JOLY

Construction:	Operation:
2011	2013

Maintenance:
Every year

Stakeholders in France:
CNRS, INRA, INSERM, MNHN, Univ. Auvergne, UPB, Univ. Nantes

Contact in France:
djian@tefor.net

www.tefor.net

The TEFOR is a distributed infrastructure: 11 platforms and labs joined forces to provide innovative services in the fields of genome editing, transgenesis, mutagenesis and imaging. Although its actvities are presently centered on two model species – zebra fish and drosophila – , TEFOR remains open to develop other model species especially through the EFOR network (www.efor.fr), but also via its several collaborations.

To ensure the high quality of its services, TEFOR conducts advanced technological research, especially to improve the use of CRISPR/Cas 9 nucleases as new tools for genome editing. TEFOR also leads systematic s large scale phenotyping program on fluorescent lines. These programs include the development of key tools such as 3D image databases with easy navigation provided.

To be on a competitive ground for functional research at the French, European and international levels, TEFOR develops a single access point for a coordinated set of services:
- service for creating lines by CRISPR/Cas9;
- several innovative transgenesis services;
- imaging services, at low or high resolution, 2D/3D/ 4D (3D+T);
- 3D images archiving in dedicated databases directly accessible through a user-friendly web interface.

SOCIO-ECONOMIC IMPACT

TEFOR collaborated with Leica-Microsystems© for the development of a new device called VibMic (a confocal microscope combined with a vibratome). Significant efforts have been undertaken to optimize clearing methods. These innovations allow deep imaging at high resolution.

Several private laboratories are among TEFOR users.

DATA

Data storage: Specific servers dedicated to TEFOR

Accessibility: Some data are free (open databases), other have restricted access (in the frame of services for some users).

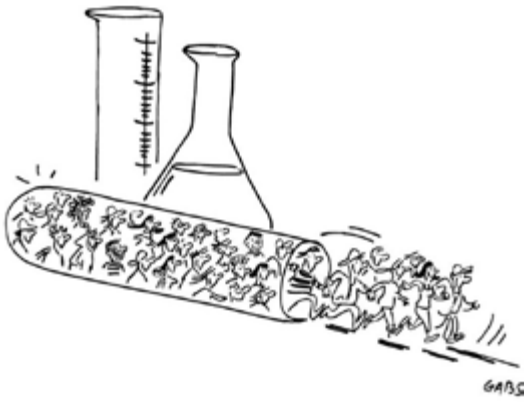
CONSTANCES

Population-based epidemiological cohorte

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 20 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 5 years) and annual linkage with the administrative databases of the CNAV, the SNIIRAM and causes of death. 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 6 years; currently (December 2015) more than 87,000 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 50 projects have been approved by the International Scientific Council of Constances.

Constances is the largest French cohort, and participates in several European consortia of population-based cohorts.



SOCIO-ECONOMIC IMPACT

The construction of the cohort follows partnerships with CNAMTS and CNAV that are providing data. Constances is used by various public health organizations (health agencies, ministry, health insurance). Partnerships have been established with several industrial companies in the field of drugs and biotechnology.

DATA

Data flow: 40,000 new participants included each year.

Data storage: 15 terabytes in total for the full cohort

Accessibility: Transmission of encrypted files by Internet (CNIL authorization required)

Presence in data networks: Participation in European consortia population cohorts with data sharing: BBMRI-LPC, IDEAR, LIFEPATH.

Construction costs

—

24 M€

Operating costs: 6 M€

Personnel

—

1.8 M€

Type: RI

Head of the Infrastructure:
Marie ZINS

Construction:	Operation:
2012	2014

Maintenance:
Permanent

Stakeholders in France:
CNAMTS, CNAV, INSERM, UVSQ

Contact in France:
marie.zins@inserm.fr

www.constances.fr

CRB-ANIM

Biological Resource Centers for domestic animals



Type: RI

Headquarters location:
Jouy-en-Josas, FR

Other sites:
Maisons-Alfort, Rennes, Lyon

Head of the Infrastructure:
Michèle TIXIER-BOICHARD

Construction:	Operation:
2012	2017

Stakeholders in France:
INRA, CNRS, FRB, VetAgro Sup.

Contact in France:
contact@crb-anim.fr

www.crb-anim.fr

The missions of CRB-Anim are to collect, characterize, conserve and distribute noninfectious biological resources for 22 domestic animal species and their wild relatives. Domestic animal species are species the evolution of which is strongly influenced by human intervention, in the frame of breeding programmes or programmes aimed at managing their genetic variability. The infrastructure is supporting research dealing with the assessment of genetic diversity and selection response, as well as the identification of mutations controlling traits of interest or genetic defects (including biomedical models). It also makes possible to preserve and restore the diversity of some endangered breeds.

Technological developments are undertaken to facilitate the collection of biological material, improve its reproductive quality and facilitate its practical use. CRB-Anim proposes sampling and conservation procedures for biological samples and offers a high quality DNA extraction service for a range of species and tissues, biological fluids or complex samples (blood, skin, muscle, fin, feces, sperm). It brings operational support to its members, particularly regarding the implementation of the Nagoya protocol.

The web portal of the infrastructure, still under construction, will offer a single entry point for users requesting storage or distribution of samples, on the basis of a minimum set of descriptors and metadata to facilitate on-line requests.

SOCIO-ECONOMIC IMPACT

Partnership with two biotechnology companies: LABOGENA and ANTAGENE.

Development of freezing methods of Seed or embryos, transferable to reproductive biotechnology companies.

DATA

Data flow: Volume < 1 To.

Data storage: Data is stored by each member of CRB Anim.

Accessibility: open data.

Presence in data networks: Labeling of data sets is foreseen in the frame of the international infrastructure GBIF.

ECELLFRANCE

French Network Infrastructure for mesenchymal stem cell (MSC)-based therapies

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 and II trials, patient immunomonitoring.

SOCIO-ECONOMIC IMPACT

20 national and European clinical trials in cell therapy, half of which come from external carriers (academic and industrial teams). Beside the public health issue and the clinical and societal impacts associated with its activities, 4 industrial partnerships with various applications (cosmetics, data analysis software, biological analysis). A CMO (T3P) creation is planned for early 2016.



Type: RI

Headquarters location:
Montpellier, FR

Other sites:
Toulouse, Clamart, Grenoble, Besançon, Créteil, Rennes

Head of the Infrastructure:
Christian JORGENSEN

Construction:	Operation:
2012	2012

Stakeholders in France:
Univ. Montpellier, CTSA, CNRS, EFS, INSERM, Univ. Toulouse, GIN Grenoble, CHU de Grenoble

Contact in France:
contact@ecellfrance.com

www.ecellfrance.com

EMBRC-FRANCE

National Marine Biological Resource Center



Type: RI

Headquarters location:
Roscoff, FR

Other sites:
Banyuls, Villefranche-sur-Mer

Contact person in France:
Bernard KLOAREG

Construction:	Operation:
2011	2015

Stakeholders in France:
UPMC, CNRS

Contact in France:
kloareg@sb-roscoff.fr

www.embrc-france.fr

The marine biological stations in Roscoff, Banyuls and Villefranche-sur-Mer, all three operated by UPMC and CNRS, offer access to boats, scientific diving, aquaria and wet labs with running seawater, analytical platforms as well as housing and catering infrastructures. Their main assets are the provision to the scientific community, on site or remotely, of microbial, algal and animal biological models, which belong to major lineages and which are not present in the terrestrial ecosystems.

Research on the marine living organisms is experiencing a major conceptual and technological revolution. Genomics, sensu lato, are now available on a variety of marine organisms and ecosystems. For a number of marine lineages, functional genomic approaches are now as developed as in canonical terrestrial models.

EMBRC-France is organized for proposing the following services:
- access to marine biodiversity, including biological or ecological experimental models, covering the whole "tree of life";
- access to wet labs and mesocosms for ex situ experimentation;
- access to technological platforms for genotyping and phenotyping of marine organisms (eg., -omics, bio-imaging, performances under cultivation);
- access to genetic resources for model organisms, whether prokaryotes or eukaryotes;
- access to numerical resources on marine biodiversity and ecosystems.

SOCIO-ECONOMIC IMPACT

EMBRC-France is servicing innovation through knowledge and technology transfer on such marine bioresources as microbes, algae or animals, by promoting biodiscovery (bioactives, biorefineries) as well as by developing new production systems (from cell factories to aquaculture). Application domains are widespread, ranging from the preparation of natural products to stock selection in aquaculture.

DATA

Presence in data networks: IFB, France Génomique, European Marine Biological Infrastructure Cluster (EMBRIC).

International dimension

"European Marine Biological Resources Center" (EMBRC), ESFRI Roadmap

Coordinator: Ilaria Nardello, FR

Partner countries: BE, EL, ES, FR, IL, IT, PT, NO, UK

Website: www.embrc.eu

FBI

France-BioImaging

The main mission of FBI is to provide access to the latest innovations in Life Science Imaging.

- As a multi-disciplinary task force to investigate new techniques in bio-imaging and encourage their application in Biological Sciences, FBI opens a large scale research tool for many areas, from research on plant or stem cells biology, to preclinical and translational studies on cancer or neurodegenerative diseases.
- As a coordinated Infrastructure FBI aims at fostering technological transfer of bio-imaging innovations from its R&D Expert Teams onto its Core Facilities, FBI speeds 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.
- As a portal for projects between public and private sectors in the field of advanced microscopy, FBI participates in the socio-economic development through industrial partnerships, the use of imaging facilities for drug or cosmetics screening and development.
- As a resource for training, FBI supports activities promoting BioImaging for life Sciences, organizes or participates to national and international education and training programs (FBI-AT; EMBO courses and workshops, ELMI meetings, MiFoBio CNRS school...).
- As an international partner, FBI with its genuine partners, is involved in diverse H2020 programs (InfraDEVSUP II Euro-BioImaging, RIA Global BioIMaging, Cost projects....) mainly in IMAGE DATA MANAGEMENT.

SOCIO-ECONOMIC IMPACT

More than 30 contractual partnerships (Imagine Optics, PHASICS, Strand Avadis...).Large scale use of the imaging platforms for drug and cosmetic screening and development (L'Oreal, Clarins, Sanofi, Servier, Roche...); 18 licenses and patents in 2014-2015. Mentoring and support of innovative startups (BioAxial, CryoCapcell, QuantaCell...)

DATA

Data flow: data production in petabytes/year.

Data storage: 50-200 Terabytes/Node of the infrastructure. FBI develops data centers, common secure Images Databases (CiD-iManage), related to software platforms.

Accessibility: Through local image data bases. Standardization is one goal of European infrastructures (EuBI, ELIXIR).

Presence in data networks: Via EuBI and Elixir, FBI is engaged in "image" data management. EuBI supports the consortium "BioMedBridges" which aims to consolidate management and interoperability of electronic resources in biomedical science.

Construction costs
—
46 M€
Operating costs: 4 M€

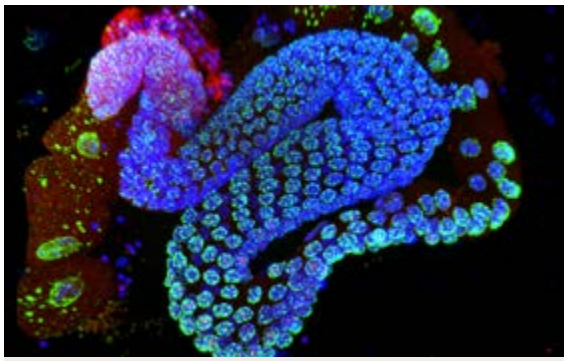
Personnel
—
150 FTE

International dimension

Euro-BioImaging, ESFRI Roadmap.

Partner countries: BE, BG, CZ, FI, FR, IT, IL, NL, NO, PO, PT, SK, SE, UK, EMBL

Website: www.eurobioimaging.eu



Type: RI

Headquarters location:
Paris

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

Head of the Infrastructure:
Jean SALAMERO

Construction:	Operation:
2011	2013

Maintenance:
Investment phase: 2012-2017

Stakeholders in France:
CNRS, ENS, Ecole Polytechnique, Inria, Inserm, Institut Curie, Institut Pasteur, AMU, Univ. Bordeaux, Univ. Montpellier, Univ. Paris VII, Univ. Paris Descartes, UPMC

Contact in France:
contact@france-bioimaging.org

france-bioimaging.org

F-CRIN

French Clinical Research Infrastructure Network



Type: RI

Headquarters location:
Toulouse, FR

Other sites:
54 national centers of clinical investigations

Head of the Infrastructure:
Olivier RASCOL, Vincent DIEBOLT

Construction:	Operation:
2012	2012

Stakeholders in France:
Inserm, CHU de Toulouse, Univ. Toulouse

Contact in France:
contact@fcrin.org

www.fcrin.org

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 13 components:
- 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
- 8 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.

SOCIO-ECONOMIC IMPACT

The national infrastructure for clinical research F-CRIN has targeted three action fields:
- complex multi-centre clinical studies;
- translational clinical research and proof of concept;
- european clinical research projects.

The infrastructure provides also clinical research trainings.

International dimension

"ECRIN/European Clinical Research Infrastructure Network" ERIC, ESFRI Landmark

Coordinator: Jacques Demotes, FR

Partner countries: 23 partners including 5 founders (FR, DE, ES, PT, IT)

Website: www.ecrin.org

FLI

France Life Imaging

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.

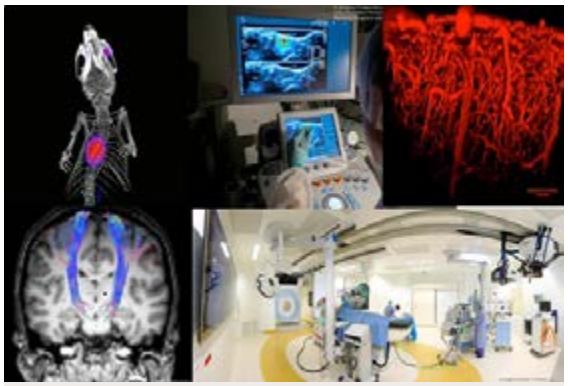
These devices reinforce the state of the art imaging equipment already installed that includes almost 160 devices of all modalities (MRI, optical imaging, PET, US, intravital imaging) dedicated to preclinical studies (57%) and to clinical and biomedical studies (43%). Associated expertise include neurosciences, cancer, cardiometabolic and infectious diseases.

FLI proposes solutions for information and data analysis and 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, "paravision®" software programming, functional MRI (fMRI) and magnetoencephalography (MEG)) and by training of PhD students and young researchers.

SOCIO-ECONOMIC IMPACT

FLI integration in the French ecosystem is ongoing with:
- the signature of a partnership with Sanofi in 2015;
- the mutual actions performed with the "pôle de compétitivité" MEDICEN enabling meetings with industrial partners;
- the setup of FORCEImaging, a network of clinical research based on imaging at hospitals.



Type: RI

Headquarters location:
Orsay, FR

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

Head of the Infrastructure:
Franck LETHIMONNIER

Construction:

2012

Stakeholders in France:
CEA, CNRS, INSERM, INRIA, USPC, AMU, Univ. Bordeaux, UdL, UGA

Contact in France:
regine.trebossen@cea.fr

www.francelifeimaging.fr

FRANCE GENOMIQUE

French national genomics and bioinformatics infrastructure



Type: RI

Headquarters location:
Evry, FR

Other sites:
22 platformes of sequencing, genotyping and bioinformatics

Head of the Infrastructure:
Pierre LE BER

Operation:
2012

Stakeholders in France:
CEA, CNRS, INRA, Inserm, INRIA, Institut Pasteur, Institut Curie, ENS, Univ. Strasbourg, UdL, Univ. Lille, AMU

Contact in France:
contact@france-genomique.org

www.france-genomique.org

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 both national and international level.

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 to meet 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.

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.

SOCIO-ECONOMIC IMPACT

France Génomique is involved in large genomics projects with high socio-economic impact (precision medicine, agronomy...) and in the development of innovative technologies, especially through its participation in early-access programs (e.g. nanopore sequencing).

A strong partnership with the Teratec/CEA HPC center (TGCC) in the field of big data for genomics.

Operating costs
—
11 M€

Personnel
—
100 FTE

FRHA

France HADRON

The France HADRON (FrHA) national infrastructure is coordinating all aspects of the applied research in proton or light ions hadrontherapy in France. Hadrontherapy is an advanced technique of radiotherapy to treat radioresistant cancers. FrHA, organized around five geographic sites, is developing in close collaboration with similar centers and networks in Europe (ENLIGHT) and Worldwide (NIRS, NAPTA). Besides scientific animation, it is co-funding access to ion beam for research teams. FrHA invests jointly with the French clinical centers for the creation of new research lines in order to contribute to the increase of the scientific host capacity.

Hadrontherapy research being multidisciplinary by nature, it concerns many fields of medicine, biology and particle physics. Research revolves strategically into 4 working packages (WP):

- WP1: Targeting and evaluation of medical interest of hadrontherapy (Clinical Research);
- WP2: Improving treatment plans (modeling and simulation);
- WP3: Improving the understanding of the effect of treatment on cells (Radiobiology);
- WP4: Enhancing the quality of treatment (Instrumentation).

This infrastructure positioned France among the leading countries in the field of clinical hadrontherapy.

SOCIO-ECONOMIC IMPACT

Hadrontherapy being an innovative medical technology, it should have a health impact in terms of cancer healing. Its present R&D programs for instrumentation aim at shorter-term applications in connection with several private actors in the field, such as Normandy Hadrontherapy (Caen), Ion Beam Application (Louvain la neuve, Belgium), AIMA (Nice).

DATA

Data flow: 0.25 To/an

Data storage: Hosts accredited for medical data

Accessibility: Restricted to research

Presence in data networks: National networks for raw data and international trade of compiled results



Type: RI

Headquarters location:
Lyon, FR

Other sites:
Caen, Orsay, Toulouse, Nice

Head of the Infrastructure:
Jacques BALOSSO

Construction:	Operation:
2013	2013

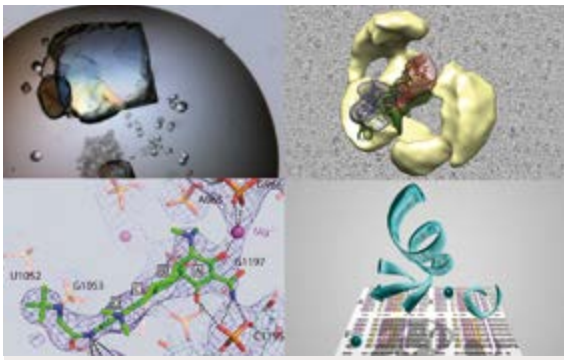
Stakeholders in France:
CNRS, AMU, Association ARCHADE, CAL, CEA, CLB, ECL, Institut Claudius Regaud, Institut Curie, INSERM, INSA, IRSN, UBP, Univ. Caen, UdL, UNS, Paris VII, Univ. Paris Sud, Univ. Toulouse, Univ. Strasbourg

Contact in France:
j-c.blouzard@ipnl.in2p3.fr

www.france-hadron.fr

FRISBI

French Infrastructure for Integrated Structural Biology



Type: RI

Headquarters location:
Illkirch, FR

Other sites:
Grenoble, Montpellier, Marseille, Paris

Head of the Infrastructure:
Bruno KLAHOLZ

Construction:	Operation:
2011	2012

Stakeholders in France:
CNRS, CEA, EMBL, Inserm, UGA, AMU, Univ. Montpellier, Univ. Paris Sud, Univ. de Strasbourg

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 proteins 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 accross 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 post master researchers.

SOCIO-ECONOMIC IMPACT

The FRISBI infrastructure has significant technology transfers between research groups and industry for technological developments and biotechnology. Several industrial partnerships are in place within FRISBI: i.e. automatization of image data collection on electron microscopes, automatic ligand screening by X-ray crystallography. Research collaboration with biotechnology industries.

International dimension

Strasbourg and Grenoble centers are also centers of Instruct Ltd.

Coordinator: Dave Stuart, UK

Partner countries: BE, CZ, DK, FR, DE, IL, IT, NL, PT, SE, SE, UK

Website: www.structuralbiology.eu

HIDDEN

Highly Infectious Diseases Dedicated Infrastructure ExtensioN

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 Inserm Jean Mérieux BSL4 laboratory is the only French civil laboratory presenting this level of biosafety containment. It proposes the largest NSB4 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 Inserm Jean Mérieux BSL4 laboratory which is under the authority of Inserm since 2004 is organized as a big infrastructure open to the whole national and international scientific community. This organisation is unique in the world for this type of infrastructure.

Due to increasing number of research programs submitted and the evolution of standards and regulation, the HIDDEN project proposes the extension of the existing BSL4 laboratories that will bring a major provision on animal experimentation capacities, diagnosis and microorganism collection management, preparedness for potential bacteria experimentation and will ensure permanent BSL4 capacity availability.

SOCIO-ECONOMIC IMPACT

The extension of the existing infrastructure will increase the impact of activities realized in strategic areas aiming at developing therapeutic, prophylactic, diagnostic tools as well as biosafety processes and thus contributing to increase French and European competitiveness in the field of highly infectious diseases.

International dimension

Infrastructure pan européenne ERINHA, ESFRI roadmap

Coordinator: Hervé RAOUL

Partner countries: FR, PT, UK, SE, EL, BE, RO, IT, SE, HU, AT

Website: www.erinha.eu



Type: RI

Headquarters location:
Lyon, FR

Head of the Infrastructure:
Hervé RAOUL

Construction:	Operation:
2011	2016

Maintenance:
Global upgrade every 18 months

Stakeholders in France:
INSERM, Fondation Mérieux

Contact in France:
herve.raoul@inserm.fr

www.p4-jean-merieux.inserm.fr/

IDMIT

Infectious Deseases Models for Innovative Therapies



Type: RI

Headquarters location:
Fontenay-aux-Roses, FR

Head of the Infrastructure:
Roger LE GRAND

Construction:	Operation:
2015	2015

Exploitation at 100% of its capacity: 2017

Maintenance: Equipement TEP-TDM containment type 2 and 3 for biological risks: 2017

Stakeholders in France:
CEA, ANRS, Bertin Pharma, Inserm, Institut Pasteur, Univ. Paris Sud

Contact in France:
infoidmit@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 extents 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.

SOCIO-ECONOMIC IMPACT

IDMIT, due to its unique expertise and technology platforms, attracts large pharmaceutical companies, domestic and international SMEs and international academic partners, particularly from Europe. Bertin Pharma, cofounder and industrial operator, contributes to the value chain of IDMIT technologies, through the development of new models and the implementation of ISO9001 certification.

Construction costs
—
37 M€
Operating costs: 4 M€

Personnel
—
42 FTE

IFB

French Institute of Bioinformatics

The French Institute of Bioinformatics (IFB) is a national service infrastructure. Its main mission is to provide core bioinformatics resources to the French life science community. The different services offered by the IFB's platforms (as described on the web site) can be grouped into 5 categories:

- data (biological information): provision of curated data collections with added value based on the biological expertise of the host laboratories;
- tools: diffusion of innovative tools for analyzing biological data developed in the host laboratories;
- IT infrastructure: making available an IT (Information Technology) facility that provides not only material resources (CPU, disk, memory, network) but also gives access to the public data collections (e.g., UniprotKB, Ensembl, etc.) and the numerous analysis tools (e.g., Blast, ClustalW, Bowtie, Velvet, etc.) used in the bioinformatics field;
- training: of the life science users to the Bioinformatics concepts and tools;
- support: to the research projects of the life science community in terms of bioinformatics analyses.

The IFB consists of 34 platforms grouped into 6 regional centers and a national hub, IFB-core, which is a joint service unit depending on 5 supervisory authorities (CNRS, CEA, INRA, Inserm, INRIA).



SOCIO-ECONOMIC IMPACT

ATGC: is a partner of the SkulTech company.

The Curie bioinformatics platform is a stakeholder of the "Carnot Curie-Cancer" institute.

ISFinder: the ISFinder database license has been transferred to DNAStar (USA).

URGI: Céréales-vallée competitiveness cluster Clermont-Ferrand.

DATA

Data flow: The IT infrastructure will be provisioned to manage and analyze several PB of data.

Data storage: The national IT infrastructure will provide 2 PB of disk storage and 2 PB of tape storage, the regional PF infrastructures provide 5 PB of storage.

Accessibility: This is one of the IFB's missions to manage data.

Presence in data networks: The IFB is part of ELIXIR, the distributed European bioinformatics infrastructure.

International dimension

IFB is the French node in ELIXIR

Coordinator: Niklas Blomberg, UK

Partner countries: BE, DK, EMBL-EBI, EE, ES, FI, FR, IL, NO, NL, PT, CZ, UK, SE, CH

Website: www.elixir-europe.org

Type: RI

Headquarters location:
Gif-sur-Yvette, FR

Other sites:
Distributed: 34 sites gathered in 6 regional centers and one national node

Head of the Infrastructure:
Jean-François GIBRAT

Construction:	Operation:
2013	2014

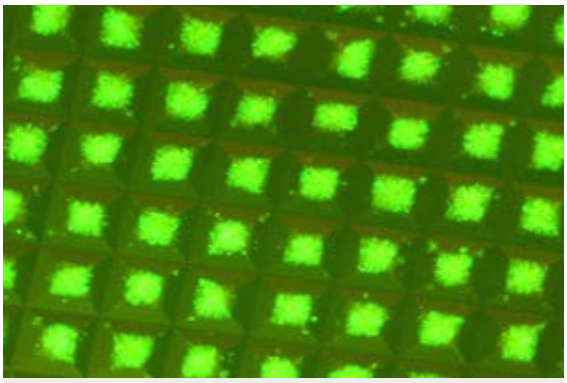
Stakeholders in France:
CNRS, CEA, INRA, INRIA, INSERM

Contact in France:
contact@france-bioinformatique.fr

www.france-bioinformatique.fr

INGESTEM

National Infrastructure for pluripotent stem cells and tissue engineering



Type: RI

Headquarters location:
Villejuif, FR

Other sites:
Évry, Strasbourg, Lyon, Montpellier

Head of the Infrastructure:
Annelise BENNACEUR GRISCELLI

Construction:	Operation:
2012	2012

Stakeholders in France:
INSERM, Univ. Paris Sud, Univ. Évry - Val d'Essonne, CNRS, Univ. Strasbourg, CHU Montpellier

Contact in France:
contact@ingestem.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.

SOCIO-ECONOMIC IMPACT

- IPS/ESC patient-specific disease models in relationship with university hospitals for research and European programs.
- "Clinical Grade" IPS Haplobank in partnership with GAIT (international network).
- Patents in cell therapy field.
- Discovery new drugs from IPS-based assays/ HTS on genetic diseases.
- Development of 3 start-ups, 1 private company.
- Partnerships with 2 pharma industries.

DATA

Presence in data networks: European registry of pluripotent stem cells
www.hescreg.eu

International dimension

Consortium International: GAIT "Global Alliance iPS Therapies"

Coordinator: Marc Turner, UK

Partner countries: USA, UK, CA, FR, KR, JP, AU, AR

METABOHUB

The French national infrastructure for metabolomics and fluxomics

Four platforms belong to MetaboHUB:
- Bordeaux (INRA, CNRS, Bordeaux Univ.);
- Clermont-Ferrand (INRA, CNRS, Blaise Pascal Univ.);
- Toulouse (Paul Sabatier Univ., INSA, INRA, CNRS, Inserm);
- Paris-Saclay (CEA, CNRS, Paris VI Univ.).

MetaboHUB is dedicated to harmonizing, implementing and up-grading the four existing platforms with common metabolomics and fluxomics tools, and methods in order to build a world-class national infrastructure.

The objective of MetaboHUB is to build an open national infrastructure and to integrate the major infrastructures network at the european level.

From 2013-2016, MetaboHUB developed tools, web services and databases necessary for metabolomics and fluxomics. From 2017, the infrastructure will provide to academic and private partners, standardized methods (website), a spectral database (PeakForest) integrated into (W4M) an ecosystem of data mining tool and computer resources to reconstruct metabolic networks (MetExplore).

The developed technologies (NMR, LC-MS, GC-MS, statistics, bioinformatics) allow high throughput biochemical phenotyping of large sample sets, the analysis of the metabolome (biological fluids of human cohorts, plant extracts, animals, micro-organisms, etc.) and high-speed measurement of metabolic flux in prokaryotic and eukaryotic cells.

SOCIO-ECONOMIC IMPACT

MetaboHUB develops tools and expertise for basic and applied research projects in the areas of human health, nutrition, food production, sustainable agriculture, green chemistry, environment and white biotechnology. MetaboHUB shares its expertise and tools with many scientific communities.

DATA

Data flow: At short term: 8.2 To. At medium term: 18 To.

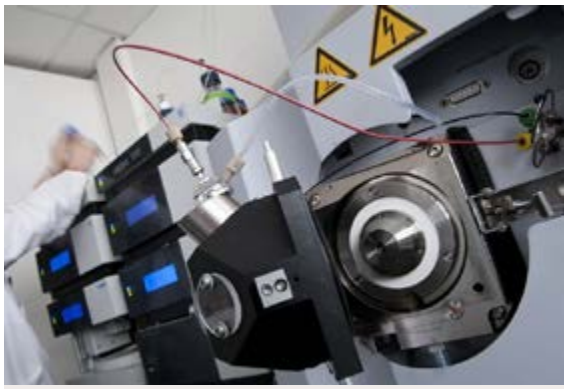
Data storage: The raw data (NMR and mass spectra) are stored at each platform (10TB to 40TB) securely (many projects, including industrial, require confidentiality). When these data are not confidential, they are deposited in the European warehouse MetaboLights.

Accessibility: The data are accessible by others as part of the consortium agreement.

MetaboHUB will provide a common framework of bioinformatics tools for the management and analysis of metabolomics data and fluxomics: Implementation of "Workflow4Metabolomics.org", interface "MetExplore" and implementation of spectral databases "PeakForest". A service to access the data and/or exploit is planned. Negotiations are underway to access the servers of France Bioinformatics order to store the raw data generated within MetaboHUB.

For each resource, part will be freely accessible to the community. MetaboHUB examines the relevance of certain advanced functionality for services which are billed as part of her mission of service.

Presence in data networks: At national level, the resource calculation "Workflow4Metabolomics" developed jointly by MetaboHUB and French Bioinformatics Institute and hosted by the latter (ABiMS platform, Roscoff, France).



Type: RI

Headquarters location:
Bordeaux, FR

Other sites:
Clermont-Ferrand, Toulouse, Saclay

Head of the Infrastructure:
Dominique ROLIN

Construction:	Operation:
2013	2017

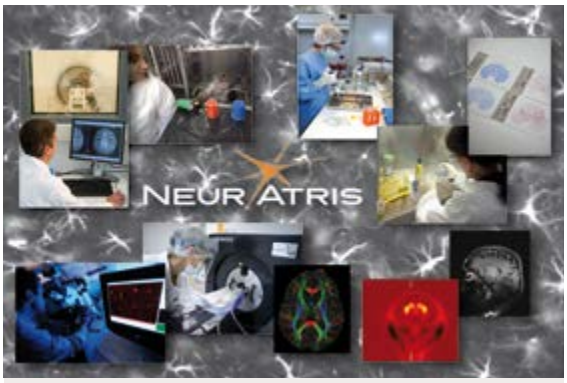
Stakeholders in France:
INRA, CEA, CNRS, INSERM, INSA Toulouse, UPB, Univ. Bordeaux, UPS, UPMC

Contact in France:
contact@metabohub.fr

www.metabohub.fr

NEURATRIS

Translational research infrastructure for innovative therapies in Neuroscience



Type: RI

Headquarters location:
Fontenay-aux-Roses, FR

Other sites:
Paris, Gif-sur-Yvette, Orsay, Evry, Créteil

Head of the Infrastructure:
Philippe HANTRAYE

Construction:	Operation:
2012	2012

Stakeholders in France:
CEA, IHU-A-ICM, Inserm, Inra, UPEC

Contact in France:
Philippe.hantraye@cea.fr

www.neuratris.com

Relying on 5 key research centers located in the Paris area, NeurATRIS, represents one of the largest concentration of neurology researchers in Europe. Grouping in one center without walls, the CEA Institute for Biomedical Imaging, the "IHU de Neurosciences Translationnelles de Paris", 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&D projects and providing services to academic, clinicians and industry in neurosciences.

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

1. developing specific lines of translational research and know-hows in Neuroscience aiming at discovering and qualifying at the preclinical and clinical level new therapeutic solutions for neurodegenerative disorders;
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.

SOCIO-ECONOMIC IMPACT

Two complementary approaches: 1) Research for Innovation through gene-, cell- and drug-based therapies and vivo functional assessment methods. 2) Research Services enabling access to high-technology platforms to access preclinical and clinical facilities and expertise in neurosciences and neurology. Main industry partners (2014): Oxford Biomedica Ltd, BrainGene, Novartis and Roche.

International dimension

International dimension

EATRIS ERIC, ESFRI Landmark

Coordinator: Anton Ussi, NL

Partner countries: NL, IT, ES, FI, CZ, FR, EE

Website: www.eatris.eu

PGT

Pre Industrial Geno Therapy Consortium

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 PGT project is structured in two phases: a phase (phase 1) in which equipment, installations and methods are designed and set up, followed by a functional and production phase (phase 2).

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.

SOCIO-ECONOMIC IMPACT

11 external users since the creation,(academics, Biotechs or Pharmaceutical companies), located in France or internationally, who develop innovative therapeutic products. This helps creating jobs and maintaining France in its leader position in the Gene Therapy vector Bioproduction domain.



Type: RI

Headquarters location:
Evry, FR

Other sites:
Saint-Herblain

Head of the Infrastructure:
Frédéric REVAH

Construction:

2011

Stakeholders in France:
Généthon, GenoSafe, Atlantic BIO GMP (ABG-EFS), CHU Nantes

Contact in France:
frevah@genethon.fr

www.pgt-consortium.fr

PROFI

Proteomics French Infrastructure



Type: RI

Headquarters location:
Grenoble, FR

Other sites:
Toulouse, Strasbourg

Head of the Infrastructure:
Jérôme GARIN

Construction:

2012

Stakeholders in France:
CNRS, CEA, INSERM, UGA, UPS, Univ. Strasbourg

Contact in France:
jerome.garin@cea.fr

www.profiproteomics.fr

ProFI is a national infrastructure combining the three leading French laboratories in the field of Proteomics. The technological and methodological developments persued 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 efficently 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.

SOCIO-ECONOMIC IMPACT

Partnerships have been set up between the ProFI infrastructure and the Transgene, Pierre Fabre, Sanofi Pasteur, Servier, Loréal, Genticell, Agronutrition, Virbac and Novalix companies.

The main objectives of these partnerships are to develop quality control of protein or cellular samples and precise characterization of proteins, in particular monoclonal antibodies.

IBISBA-FR

Industrial Biotechnology Innovation and Synthetic Biology Accelerator

IBISBA-FR is a distributed (Ile de France, Toulouse region...) intermediate stage (TRL3-5) R&D infrastructure. IBISBA-FR's key missions are to:

1. promote industrial biotechnology and underpin the development of the bioeconomy fostering applications to the renewable carbon sector;
2. catalyze scientific innovation;
3. 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 and its HQ (TWB (Toulouse), a biotechnology pre-industrial demonstrator) is associated with an extensive public-private partnership involving 23 companies. IBISBA-FR provides R&D services including:

- the funding and hosting of high-risk, R&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&D offers for companies wishing to advance their biotechnology projects towards industrialization;
- multiple R&D offers for National and European funded consortia.

SOCIO-ECONOMIC IMPACT

Through TWB, IBISBA-FR has achieved several notable successes:
55 projects launched at the end of 2015, 18 M€ worth signed contracts and 11 patents filed. Creation of EnobraQ, a startup built on a precompetitive research project (Carboyeast) and funding mainly by Sofinnova, an independent venture capital firm.

International dimension

EU-IBISBA project under construction

Coordinator: Michael O'Donohue, FR

Partner countries: FI, IT, ES, EL, SE, UK, NL, PO, BE, DE

Website: www.ibisba.com



Type: Project

Headquarters location:
Toulouse, FR

Other sites:
Ile-de-France region

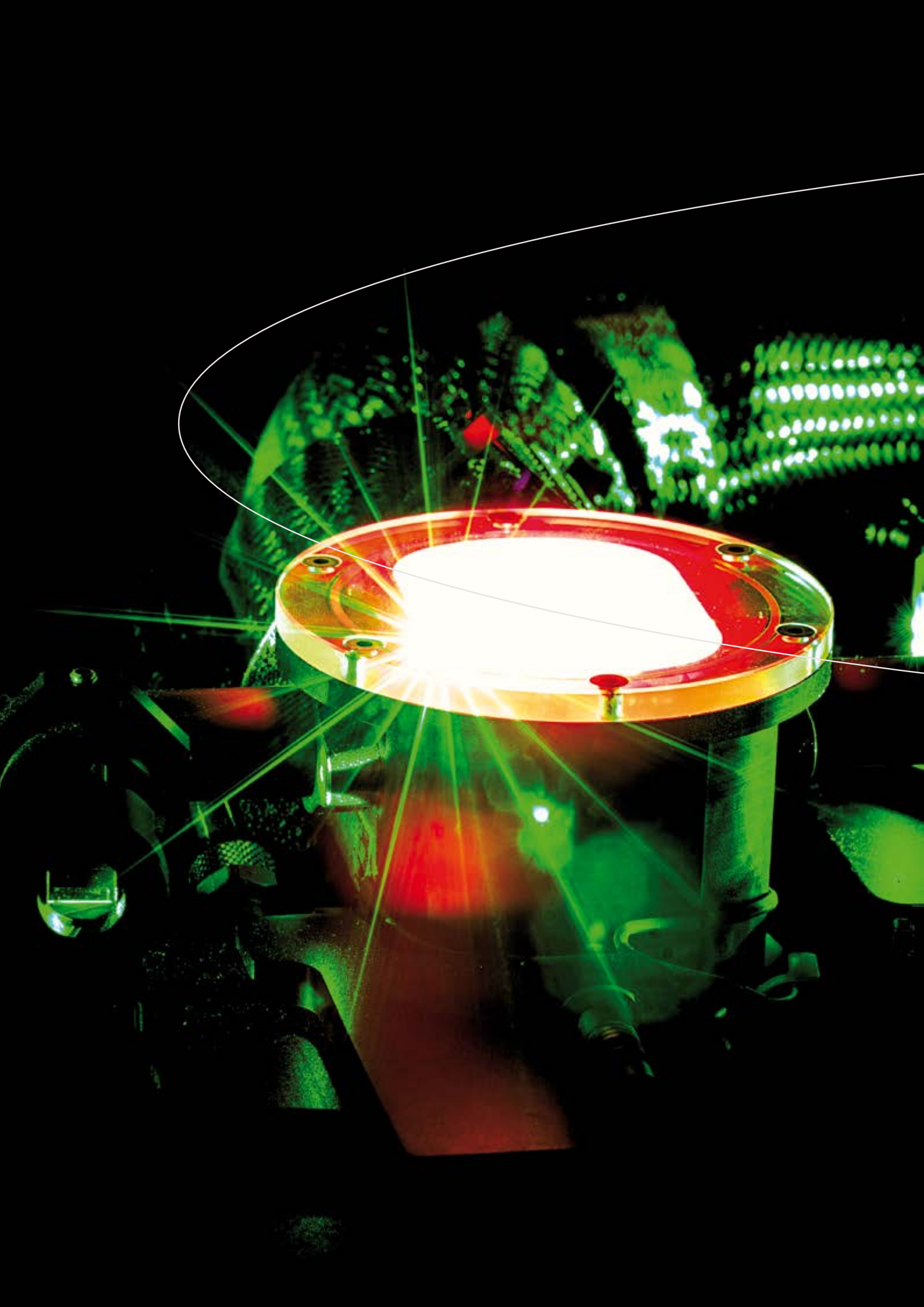
Head of the Infrastructure:
Michael O'DONOHUE

Construction:	Operation:
2010	2012

Stakeholders in France:
CNRS, CEA, INRA, INSA

Contact in France:
michael.odonohue@insa-toulouse.fr

www.ibisba.com



MATERIAL SCIENCES AND ENGINEERING



Material Sciences and Engineering

The research infrastructures devoted to material sciences and engineering, the synchrotron radiation centres (ESRF, SOLEIL), the neutron scattering centres (ILL, LLB-ORPHEE), the intense laser centres (LULI-APOLLON and PETAL) in France as well as the European projects, the intense pulsed source (XFEL in Hamburg), the spallation neutron source (ESS in Lund), the intense magnetic field centre (LNCMI/EMFL) but also the platform networks (EMIR, RENARD, RENATECH, METSA, RMN-THC, FT-ICR) are characterised by the use of probes of different natures: radiation covering the widest electromagnetic spectrum, millimetre waves with very hard X-rays, even gamma rays; the photons delivered by Ultra High Intensity (UHI) lasers or High Energy Density (HED); neutrons, with a high capacity of penetration into matter and intense magnetic fields.

These infrastructures are places where strong synergies are created between "machine" engineers, technicians, physicists on the one hand and user-scientists of the various disciplines. They make it possible today to offer constantly optimised and increasingly modernised research tools, which meet the expectations of the scientific communities. The coordination committee on very large research infrastructures (VLRI) formed of the CEA and of the CNRS ensure the maintaining of the diversity and multidisciplinarity of these infrastructures in accordance with the National strategy for research and innovation.

The access combined with the various infrastructures, often in a complementary manner, allows scientists to make unique progress in the development of the knowledge of matter in all of its forms (gas, liquid, solid, plasma) and by reproducing all the extreme conditions in laboratory (very high pressure, high and very low temperatures, high magnetic fields). All basic scientific fields are concerned: physics, chemistry, astrophysics, geology, biology, archaeology, palaeontology, and cultural heritage. As such, these infrastructures participate in answering the most basic scientific questions while still contributing to progress in most applied fields such as energy and health. By making it possible to characterise materials, they participate, in particular, in the development of nanoelectronics and nanosciences.

The development of technologies on a nanometric scale has led engineers in many key sectors of the economy to form matter and observe it by using tools for synthesis and observation that, until now, were used almost exclusively by researchers. This trend is increasing substantially today and should accelerate in the upcoming years, providing to sites equipped with large infrastructures, an additional power of attractiveness for industrial development.

LIST OF RESEARCH INFRASTRUCTURES MATERIAL SCIENCES AND ENGINEERING

TYPE	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	ILL	Institut Max von Laue - Paul Langevin	ILL Upgrade Ph 1 (2006)
VLRI	Orphée/LLB	ORPHEE/Laboratoire Léon Brillouin	
VLRI	Soleil	French national synchrotron facility	
VLRI	XFEL	European X-ray Free Electron Laser	XFEL (2006)
RI	EMIR	Federation of the accelerators for the studies of materials under irradiation	
RI	FT-ICR	Very high field FT-ICR mass spectrometer national network	
RI	LNCMI	The National High Magnetic Field Laboratory	EMFL (2008)
RI	LULI-APOLLON	Laboratory for the Use of Intense Lasers	
RI	METSA	Transmission Electron Microscopy and Atom Probe	
RI	PETAL	PETAwatt Aquitaine Laser	
RI	RMN	Magnetic Nuclear Resonance, Very High Fields	
RI	Renard	Research Infrastructure Interdisciplinary EPR National Network	
RI	RENATECH	French national nanofabrication network	
Project	*ERIHS-FR*[1]	*European Research Infrastructure for Heritage Science*	*ERIHS (2016)*

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

ESRF

European Synchrotron Radiation Facility



Type: VLRI, Limited company under French law

Headquarters location:
Grenoble

Head of the Infrastructure/
Contact person in France:
Amina TALEB-IBRAHIMI,
Patricia ROUSSEL-CHOMAZ

Construction:	Operation:
1988	1994

Maintenance: 2009-2015 Upgrade Phase I
2015-2022 ESRF-Extremely Brilliant Source, ESRF-EBS

Stakeholders in France:
CNRS, CEA

Contact in France:
amina.taleb@cnrs-dir.fr
patricia.roussel-chomaz@cea.fr

www.esrf.eu

The ESRF is the European synchrotron radiation source producing high-energy X-rays (very hard x-rays ranging from 10 to 300 keV) which are distributed over 43 experimental stations (beamlines) available to the scientific community, which benefit from 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. Similar programmes are already in advanced study in the US, Japan and China.

SOCIO-ECONOMIC IMPACT

Partnerships and interaction with industry are present at different levels:
- commercial contracts with industrials (2.2 M€ of income in 2014);
- joint conception and development of innovative devices (30 technology transfer licences);
- economic return: since 1988, over 2 B€ spent in the commercial and industrial sectors.

DATA

Data flow: 2 PB/year

Data storage: Stockage at ESRF

Presence in data networks: FP7 and H2020 projects for the improvement of aspects linked to the ownership, storage, archiving, treatment and access to data.

Construction costs

2,598 MF (1987) + ESRF II UP Phase 1 = 168 M€; ESRF - EBS = 149.1 M€
Operating costs: 100 M€ including 27.5 M€ of French contribution

Personnel

597.5 FTE

International dimension

ESRF-Extremely Brilliant Source, ESFRI Landmark

Coordinator: Francesco Sette, General Director

Partner countries: FR (27.5%), DE (24%), IT (13.2%), UK (10.5%), SE (4%), CH (4%), RU (6%), Benesync BE, NL (5.8%), Nordsync DK, FI, NO, SE (5%)

8 associated countries: IL (1.5%), PL (1%), PT (1%), AT (1.3%), CentralSync HU, CZ, SK (1.05%), ZA (0.3%)

Website: www.esrf.eu

ESS

European Spallation Source

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 ultracold 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 energy of 2.5 GeV impinging a tungsten target with a beam power of 5 MW. This source will produce long neutron pulses (2.86ms at a frequency of 14 Hz) with a peak neutron flux 30 times higher than the American spallation source SNS (short pulses).

ESS should produce its first neutrons at the end 2019, and operate at full power in 2023-2025 with 16 spectrometers.

SOCIO-ECONOMIC IMPACT

Creation around ESS and the Max IV Synchrotron, of a center gathering research facilities, universities, and companies linked to innovation and research.

DATA

Data flow: 2 PB/year

Data storage: DMSC: Data Management and Software Center located at Copenhague

Construction costs

—

1,843 M€ including 147.5 M€ of French contribution

Operating costs: 120 M€ including 10 to 12 M€ of French contribution

Personnel

—

450 FTE

International dimension

ESS ERIC, ESFRI Landmark

Coordinator: Jim Yek, Director General

Partner countries: SE (35%), DK (12.5%), DE (10%), UK (9.8%), FR (8%), IT (5.66%), ES (4.73%), CH (3.5%), NO (2.5%), PL (2%), HU (0.95%), CZ (2%), EE (0.25%), LT (0.45%)



Type: VLRI, ERIC

Headquarters location:
Lund, SE

Contact person in France:
Patricia ROUSSEL CHOMAZ,
Amina TALEB-IBRAHIMI

Construction:	Operation:
2014	2023-2025

Stakeholders in France:
CNRS, CEA

Contact in France:
patricia.roussel-chomaz@cea.fr
amina.taleb@cnrs-dir.fr

europeanspallationsource.se

ILL

Institut Max von Laue - Paul Langevin



Type: VLRI, Limited company under French law

Headquarters location:
Grenoble, FR

Contact person in France:
Amina TALEB-IBRAHIMI,
Patricia ROUSSEL-CHOMAZ

Construction:	Operation:
1969	1971

Maintenance:
1979-1987: Second souffle (renewal of infrastructures et instrumentation)
1991-1995: complete reconstitution of the reactor
2001-2016: Millennium (instrumentation renewal plan)
2002-2007: Refit (complience of certain infrastructures required by ASN)
2012-2016: Complementary safety evaluations and renewal of key elements of the reactor
2015: Endurance (Instrumentation renewal plan)

Stakeholders in France:
CNRS, CEA

Contact in France:
amina.taleb@cnrs-dir.fr
patricia.roussel-chomaz@cea.fr

www.ill.eu

The ILL is a European large-scale research facility, with three Associate country members and 11 Scientific Members. It operates a high-flux neutron source (58 MW), providing neutrons to 38 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 at the ILL). ILL research covers a wide range of science (including biology, chemistry, soft matter, fundamental and nuclear physics, and materials science). To maintain its position as the most productive neutron source in the world, ILL launched the Millennium program in 2001. This two-phase upgrade of its scientific and technical facilities produced a factor 24 gain in neutron detection rates. A third phase of modernization ("Endurance" 2016-2023) is now starting, providing for 12 instrument projects, the renovation of 3 neutron guides and improved data processing and sample environment facilities. Endurance Phase 1 (2016-2018) was approved by the ILL Steering Committee in December 2015. The ILL currently 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.

SOCIO-ECONOMIC IMPACT

Over 50 French and European companies use ILL for R&D purposes and 30% of the projects are of industrial interest [transport, space and energy, construction, medicine (medical radioisotopes) and pharmaceutics].

ILL generates significant employment and sales returns for the national and regional economy (M€ 30 is spent from the ILL's budget every year on regional companies). Return on investment is estimated at a 3.5 factor.

DATA

Data flow: About 200 TB/year.

Data storage: Data storage is provided by ILL.

Accessibility: ILL's data access policy is a pioneer in the field (European PaNdata programmes).

Construction costs

248 MF (1971)
Refit = 29.7 M€ (2007), Reactor key elements = 27 M€ (2016), Millennium (phases 1+2) = 77 M€ (2016), Endurance (phases 1+2) = 62 M€

Operating costs: 94 M€ including 24. 21 M€ of French contribution. Plus for France: 8 M€ for VAT and 2.3 M€ for nuclear tax (CEA).

Personnel

490 FTE

International dimension

ILL, ESFRI Landmark

Coordinator: William George Stirling

Partner countries: FR, DE, UK with equal parts

ORPHEE/LLB

ORPHEE/Laboratoire Léon Brillouin

Orphée reactor is the French national neutron source dedicated to matter characterization. With a 14MW 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).

SOCIO-ECONOMIC IMPACT

15% of the beam time is used for industrial purposes via academic or contractual collaborations.

1 to 2 patents per year are deposited by members of the infrastructure.

DATA

Data flow: 50 GB and soon 100 GB of data per year.

Data storage: The storage is provided by a 25TB RAID disk server.

Accessibility: Data are available on internal servers.

Operating costs

—

LLB: 3.4 M€
Orphée: 8.5 M€

Personnel

—

Orphée: 60 FTE
LLB: 71 FTE



Type: VLRI

Headquarters location:
Gif-sur-Yvette, FR

Head of the Infrastructure:
Christiane ALBA-SIMIONESCO

Construction:	Operation:
1974	1980

Stakeholders in France:
CEA, CNRS

Contact in France:
llb-sec@cea.fr
experience-llb@cea.fr

www-llb.cea.fr/index.php

SOLEIL

French national synchrotron facility



Type: VLRI, Limited company under French law

Headquarters location:
Gif-sur-Yvette, FR

Head of the Infrastructure:
Jean DAILLANT

Construction:	Operation:
2002	2008

Maintenance:
2017: 29 lines
2020: Upgrade machine

Stakeholders in France:
CNRS, CEA, Ile-de-France and Centre-Val de Loire regions, Essone department

Contact in France:
jean.daillant@synchrotron-soleil.fr

www.synchrotron-soleil.fr

SOLEIL is, at the same time, an extremely brilliant light source, acting as a service platform open to all scientific and industrial communities, as well as a research laboratory at the cutting edge of experimental techniques. National synchrotron radiation source, SOLEIL aims to explore matter at different scales.

The radiation is produced by high energy electrons (2.75 GeV) circulating at a speed close to that of light, in a ring of 354 m circumference. This radiation spans an energy range from infra-red to X-rays, and SOLEIL is optimized for the production of radiation in the medium energy X-ray range. The radiation is guided towards the 29 beamlines at SOLEIL, each one being an instrumented laboratory designed for the preparation and analysis of studied samples, as well as for the analysis of the resulting measurements.

The spectrum of analysis methods available at SOLEIL covers spectroscopy (very high spectral resolution, time-resolved), diffraction and scattering (kinetics, consistency), three-dimensional imaging (very high spatial resolution, phase contrast, multi-scale and multi-modal).

SOLEIL, which furnishes approximately 10% of beamlines available in the European research area, is renowned for its beam quality as being amongst the best sources in the world.

SOLEIL enables to lead fundamental and applied researches from physics to heritage, passing via biology, chemistry, space or environmental science.

SOCIO-ECONOMIC IMPACT

Industrial use of SOLEIL beamlines (70 service contracts in 2015 for 230k€, partnerships in selected R&D projects) represents more than 10% of the volume of external projects.

Since 2003, 26 patents (11 inventions) and 6 projects of knowledge transfer to industry.

The construction and operation of equipment at SOLEIL has a high economic impact (in 2015, 3,500 orders to a total of 15 M€).

DATA

Data flow: several tens of TB/day of operation.

Data storage: Data management around the TANGO core. Several levels of storage (local, primary, secondary or long term) are available.

Accessibility: To users for a period of 100 days after project completion.

Presence in data networks: PaNDaaS: Informal collaboration between neutron and synchrotron sources.

Construction costs

473 M€
Operating costs: 63 M€

Personnel

341.35 FTE

XFEL

European X-ray Free Electron Laser

XFEL is an extremely intense and coherent source of X-rays generated in the form of very short pulses, in construction in Hamburg, with users operation starting in 2017. Its brilliance is a billion times higher than that of conventional X-ray radiation sources and very short wavelengths (0.05 nm) will be accessible.

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 (Technology developed at DESY in Germany). Crossing undulators, these electrons will generate flashes of X-rays coherent thanks to the self-amplified spontaneous emission phenomenon (SASE). These flashes of duration <100 fs will open up areas of research previously inaccessible: as the direct visualization of atomic movements and temporal analysis, imaging of individual particles and the structure determination of macromolecules... 6 experimental stations will be constructed in a first phase, which will give new perspectives in different fields.

XFEL infrastructure is complementary to ESRF and SOLEIL based in France. At an international level, XFEL will be more powerful in terms of electron energy and brightness than the other facilities, and it will produce 27,000 pulses per second instead of the 60 of SACLA (Japan) or the 120 of LCLS (USA).

DATA

Data flow: Several Gigaflops are expected.

Data storage: The storage capacity will be of 10 PB, increasing to 100 PB.

Accessibility: restrictive data access to internal users and close research collaborators.

Construction costs

1,226 M€ (€ 2005) including 38.5 M€ of French contribution

Operating costs: 2.4 M€ of French contribution

International dimension

XFEL, ESFRI Landmark

Coordinator: Massimo Altarelli, General Director

Partner countries: FR (3.14%), DE (57.8%), RU (26.69%), DK (0.96%), ES (0.96%), HU (0.96%), IT (2.87%), PL (2.16%), SK (1.11%), SE (1.52%), CH (1.48%)

Website: www.xfel.eu



Type: VLRI, GmbH

Headquarters location:
Hamburg, DE

Contact person in France:
Maria FAURY, Amina TALEB-IBRAHIMI

Construction:	Operation:
2009	2017

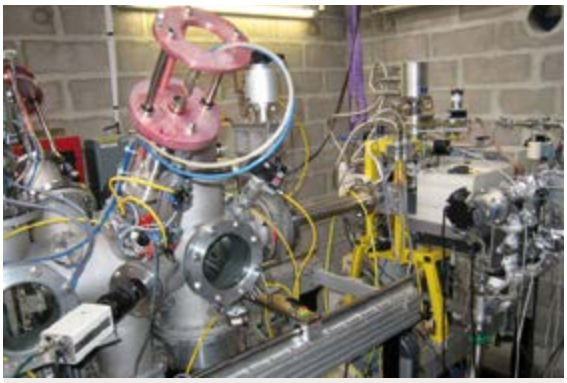
Stakeholders in France:
CEA, CNRS

Contact in France:
maria.faury@cea.fr
amina.taleb@cnrs-dir.fr

www.xfel.eu

EMIR

Federation of the accelerators for the studies of materials under irradiation



Type: RI

Headquarters location:
Caen, FR

Other sites:
Orléans, Orsay, Palaiseau, Saclay

Head of the Infrastructure:
Serge BOUFFARD

Construction:	Operation:
2014	2014

Stakeholders in France:
CNRS, CEA, Ecole Polytechnique, Univ Orléans, Univ Caen-Normandie, Ensicaen

Contact in France:
bouffard@ganil.fr

emir.in2p3.fr

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, and 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.

SOCIO-ECONOMIC IMPACT

A large majority of experiences are related to industrial concerns and are related to the Nuclear Energy Direction at CEA, AREVA, EDF and the research on materials for fusion reactors

Operating costs
—
0.83 M€

Personnel
—
8 FTE

FT-ICR

Very high field FT-ICR mass spectrometer national network

The national network of very high field FT-ICR mass spectrometers is structured as a research federation encompassing six 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 available experimental time), as well as expertise in the field.

Its instruments (with 7 to 9.4T 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.

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.

SOCIO-ECONOMIC IMPACT

Some sites are especially involved in large regional projects, such as Metz in the Verbilor project (Energy recovery in high temperature biomass reactor) or Lille in the Energy Transition Institute (ITE) and the French Institute for Agro-sourced materials (IFMAS).

DATA

Data flow: Max 1 TB/day

Data storage: Data storage managed by each site

Construction costs

—

5.8 M€

Operating costs: 0.349 M€

Personnel

—

10.8 FTE



Type: RI

Headquarters location:
Palaiseau, FR

Other sites:
Paris, Lille, Metz, Orsay

Head of the Infrastructure:
Guillaume VAN DER REST

Construction:	Operation:
2010	2010

Stakeholders in France:
CNRS, École polytechnique, ESPCI ParisTech, Univ. Lille 1, Univ. Lorraine, Univ. Pierre et Marie Curie, Univ. Paris Sud

Contact in France:
guillaume.van-der-rest@u-psud.fr

www.fticr.org

LNCMI

The National High Magnetic Field Laboratory



Type: RI

Headquarters location:
Toulouse

Other sites:
Grenoble, FR

Head of the Infrastructure:
Geert RIKKEN

Operation:

2009

Stakeholders in France:
CNRS, INSA-T, Univ. Toulouse, UGA

Contact in France:
lncmi.direction@lncmi.cnrs.fr

lncmi.cnrs.fr

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 of 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.

SOCIO-ECONOMIC IMPACT

On average, 2 industrial contracts are ongoing for the development of magnetic field sources or the testing of materials and devices under high magnetic field or under magnetic levitation.

DATA

Data flow: 1 GB/year

Operating costs
—
3.5 M€

Personnel
—
130 FTE

International dimension

AISBL 'European Magnetic Field Laboratory' (EMFL)

Coordinator: Martin van Breukelen (NL)

Partner countries: FR, DE, NL, UK

Website: www.emfl.eu/home.html

LULI-APOLLON

Laboratory for the Use of Intense Lasers (LULI)

The LULI research infrastructure 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 plasmas created by laser. It operates LULI2000 installation, on the campus of Ecole Polytechnique, built and will operate the APOLLON facility on the site of "l'Orme des Merisiers" and leads specific developments in order to continuously improve their performances and meet user demand.

LULI2000, thanks to the coupling on target of high-energy and high power pulses, allows reproducing in the laboratory, and to study distant plasmas (planetary cores, stars...), possibly magnetized, and to better understand the physics behind of fusion energy concepts.

APOLLON, which is designed to ultimately deliver 10 PW, will produce, thanks to its extreme light intensity, particle beams and radiation with unraveled characteristics, pushing back the boundaries of fundamental research.

Open to the national and international scientific community from 2018, it will allow exploring novel topics (high-field physics, particle acceleration above the GeV) and innovative multidisciplinary applications (relativistic astrophysics, chemistry under irradiation...).

SOCIO-ECONOMIC IMPACT

The infrastructure is a key player in the R&D activities on the Plateau de Saclay. Twelve patents have been issued since 2004 (mainly on diode-pumped solid-state laser technology) and 2 start-ups co-funded. Technology transfer activities, notably to Thales, have been initiated in the framework of the APOLLON project.

Construction costs

—

8 M€ LULI2000 + 27 M€ APOLLON (excluding personnel)

Operating costs: from 3.7 M€ in 2015 to 4.9 M€ in 2020 (excluding personnel)

Personnel

—

56 FTE

International dimension

LASERLAB-EUROPE

Coordinator: LLC (SE)

Partner countries: 30 laboratories in 16 countries; 20 infrastructures

Website: www.laserlab-europe.net



Type: RI

Headquarters location:
Palaiseau

Other sites:
Gif-sur-Yvette, FR

Head of the Infrastructure:
Patrick AUDEBERT

Construction:	Exploitation:
1994	2003 (LULI) and 2018 (Apollon)

Stakeholders in France:
CNRS, Ecole Polytechnique, CEA, UPMC

Contact in France:
patrick.audebert@polytechnique.edu
luli@luli.polytechnique.fr

www.luli.polytechnique.fr

METSA

Transmission Electron Microscopy and Atom Probe



Type: RI

Headquarters location:
Orsay, FR

Other sites:
Strasbourg, Toulouse, Lyon, Rouen, Caen, Paris, Marseille, Grenoble

Head of the Infrastructure:
Mathieu KOCIAK

Construction:	Operation:
2009	2012

Stakeholders in France:
CNRS, CEA, Universities

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 the 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 mutualization, 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.

SOCIO-ECONOMIC IMPACT

Most of the experiments performed in the frame of METSA concern advanced research and innovation projects (thesis, ANR, industrial R&D, relations with industries and competitiveness clusters).

DATA

Data flow: several tens of TB/year spread over 8 platforms.

Operating costs
—
0.25 M€

Personnel
—
4 FTE

International dimension

2 platforms are associated to the european network ESTEEM2

Coordinator: Etienne SNOECK, FR

Partner countries: FR, SE, UK, BE, NL, PL, SI, DE, ES, AT

Website: esteem2.eu

PETAL

PETAwatt Aquitaine Laser

PETAL is a high energy and high power laser, within the LMJ facility. PETAL generates a kJ and 0.5-10 picosecondes duration pulse coupled with the high energy beams of the LMJ.

The objectives of PETAL are:

1. To obtain in laboratory extreme states of matter, representative of the conditions 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 brief radiations 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 the material, to increase our knowledge of the Universe.
4. Particles physics and Nuclear physics, with the generation of high-energy protons beams, to probe plasmas, or for the study of proton-therapy (treatment of cancerous tumors); nuclear reactions in plasmas, nucleo-synthesize, and activation of nuclei.

The objectives are detailed in "LMJ-PETAL Scientific Case" (www-lmj.cea.fr/).

SOCIO-ECONOMIC IMPACT

The development of the necessary technologies gave rise to scientific collaborations of the CEA with national and international laboratories. The main innovations concerned the optical components and their processing, the laser front end and the compressor. The CEA leaned on numerous industrial partners; most of them are members of the Competitiveness cluster "Route des Lasers".

DATA

Data flow: 10 GB/year and 50 GB/year at medium-term.

Data storage: On CEA and University of Bordeaux secure network

Construction costs

—

54.3 M€ (2007), 15.6 M€ (LMJ integration)

Equipex "PETAL+" for the realisation of first disgnostics for 8 M€

Operating costs: 1.3 M€

Personnel

—

1 M€



Type: RI

Headquarters location:
Le Barp, FR

Head of the Infrastructure:
Jean-Pierre GIANNINI

Construction:	Operation:
2008	2016

Stakeholders in France:
CEA, Nouvelle Aquitaine region

Contact in France:
userLMJ@cea.fr

petal.aquitaine.fr

RMN-THC

Magnetic Nuclear Resonance, Very High Fields



Type: RI

Headquarters location:
Grenoble, FR

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

Head of the Infrastructure:
Jean-Pierre SIMORRE

Construction:	Operation:
2007	2008

Maintenance:
2016 new spectrometer 1.2 GHz

Stakeholders in France:
CNRS, CEA, UGA, Univ. Lille, UCBL, ENSL, UBx1, IPB, UBxS, INSERM, UPMC, ENS Paris

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

www.ir-rmn.fr

The NMR-THC infrastructure consists of NMR research teams who operate and supervise the use of the French NMR spectrometers at very high fields.

This network is a national and transnational access-providing infrastructure. It is localized in 7 research laboratories and consists of 11 NMR spectrometers ranging from 750 Mhz to 1 GHz. The access possibilities to the advanced equipments are accompanied by expertise and scientific support internationally recognized.

Multidisciplinary, the network covers a wide area of applications in biology, chemistry, physics, Earth science and astronomy, medicine... 30% of the open access time on its NMR spectrometers is distributed through open application calls. The infrastructure allows to unite, energize and promote research and to coordinate and optimize national investments in the field of NMR at very high fields.

At the international level, France is extremely well positioned by holding two 950 MHz spectrometers on the five existing, one spectrometer 1 GHz, the most powerful in the world, as well as unique equipments (cryoprobes, specific DNP and solid state NMR probes). The leadership position of France will be strengthened by the acquisition of a 1.2 GHz spectrometer that will be implemented at Lille at the end of the decade.

SOCIO-ECONOMIC IMPACT

Using the NMR infrastructure at very high fields contributes to scientific advances in societal research axes (health, environment, information, nanotechnology...) in partnership with competitiveness clusters, (Elastopôle, Cosmetic Valley, MAUD...), Carnot institutes and different industries (Cephalon, Alcan, Michelin, Messier-Bugatti...).

Several patents are deposited annually per site.

Construction costs

Projet 1.2GHz: 15 M€
Operating costs: 1.2 M€

Personnel

30.83 FTE

RENARD

Interdisciplinary Electron Paramagnetic Resonance National Network

The RENARD federation is a decentralized infrastructure combining 27 EPR spectrometers (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.

SOCIO-ECONOMIC IMPACT

Current industrial users of the Federation are the companies TOTAL HUTCHINSON, SANOFI, l'OREAL.

Very strong implications are also to be acknowledged with CNES for the specialization of the EPR and IRSN for predictive dosimetry.

DATA

Data flow: 1TB for the whole federation.

Data storage: Data storage managed by each site.

Accessibility: Free data access.

Operating costs
—
0.3 M€

Personnel
—
16.35 FTE



Type: RI

Headquarters location:
Lille, FR

Other sites:
Strasbourg, Grenoble, Marseille, Paris

Head of the Infrastructure:
Hervé VEZIN

Construction:	Operation:
2012	2012

Maintenance:
2015-2017 (2 new spectrometers)

Stakeholders in France:
CNRS, AMU, UTLN, UMPC, Chimie ParisTech, Univ. Paris Descartes Paris V, Univ. Lille, Unistra, UGA, CEA

Contact in France:
herve.vezin@univ-lille1.fr

renard.univ-lille1.fr

RENATECH

French national nanofabrication network



Type: RI

Headquarters location:
Orsay, FR

Other sites:
Lille, Besançon, Marcoussis, Grenoble, Toulouse

Head of the Infrastructure:
Michel DE LABACHELERIE

Construction:	Operation:	Maintenance:
2003	2003	2016-2020

Stakeholders in France:
CNRS, Universities

Contact in France:
michel.labachelerie@cnrs-dir.fr

www.renatech.org

The RENATECH network is gathering infrastructure and heavy equipment in micro- & nanotechnology, distributed on the national territory, within six facilities heavily involved in micro- & nanotechnology development. Together, these facilities represent 7,000 m² of clean rooms 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, micro-nanotechnologies for biosciences, characterization and instrumentation.

The 6 facilities are belonging to the following laboratories:
- the Institute of Electronics, Microelectronics and Nanotechnology (IEMN) in Lille;
- the Institute of Fundamental Electronics (IEF) in Orsay;
- the Laboratory for Photonics and Nanostructures (LPN) in Marcoussis;
- the FEMTO-ST Institute (Franche-Comté Thermal Mechanical Electronics and Optics - Science & Technology) in Besancon;
- the laboratory of microelectronic technologies (LTM) in Grenoble and 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.

SOCIO-ECONOMIC IMPACT

Renatech is a technological tool on which a wide academic or industrial community depends. Each year, a Micro- & Nanofabrication service is offered to about 100 industrial users of which one half are SMEs. The network owns a portfolio of 147 patents and 29 priority patents were filed in 2013. In addition, 10 start-up companies have been created since 2009.

Construction costs

200 M€
Operating costs: 8 M€

Personnel

140 FTE

International dimension

International unit UMI-LN2 between CNRS and Sherbrooke university (CA).

Coordinator: Michael Canva

Partner countries: France, Canada

Website: www.labn2.fr



ASTRONOMY AND ASTROPHYSICS

Astronomy and Astrophysics

Astrophysics deals with the history of the universe and of its constituents, from its beginnings dominated by physical phenomena which are still not very well known to its growing complexity, with the formation and evolution of galaxies, stars and planetary systems, up to the emergence of life. It is based on increasingly detailed observations and makes use of theoretical work and digital modelling and is opening up to laboratory experiments. The level of accuracy required to constrain the models requires observatories on the ground and in space with an ever-increasing degree of performance which now belong, because of their complexity, cost and international character, to the VLRI class. Beyond the conventional observation in the optical field, observation has expanded to the entire electromagnetic spectrum and is now open to new messengers such as gravitational waves or neutrinos. This multi-spectral and multi-messenger investigation makes it possible to cover the various physical processes involved, to browse through the history of the universe and of its constituents. The implementation of those observation facilities, the tools for analysing and storing the data as well as the numerical simulations are carried out in the vast majority of cases within an international framework, bilateral for medium-sized infrastructures, in a European framework for most of them, and on a worldwide scale in a few cases.

The strategy of the discipline in terms of research infrastructures is based on the reflection carried out during prospective scientific exercises organised every five years by CNRS-INSU, which elaborate the priorities for evolution in the means with all of the institutional stakeholders and the scientific community; it takes into account the European and international strategies on the ground and in space, the interfaces with other disciplines and the output from prospective scientific seminars organised on a regular basis by CNES for the space domain. The conclusions of the latest prospective seminars led by INSU and CNES in 2014 will naturally be used as input for the national roadmap. Since the 2009 exercise, the national prospective is conjugated with the European strategies defined by the **ASTRONET ERA-NET**, which groups together the agencies that finance astronomy and covers all aspects of the discipline, from the study of the Sun and the solar system to that of the borders of the universe, and by the **ASPERA ERA-NET**, dedicated to astroparticles, and its successor, the APPEC Consortium. The European roadmap **ESFRI** and **ESA's *Cosmic Vision* Programme** also play a structuring role. The key scientific questions identified in the document **"A science vision for European astronomy"** produced by ASTRONET in 2007 and updated in 2013, backed by the national prospective, are as follows: Do we understand how the universe works in the extreme conditions that can be found in it? How are galaxies, stars and planets formed and how do they evolve? How does our own solar system and how do we ourselves find our place?

The International Organisation ESO (European Southern Observatory) operates very large ground telescopes on its sites in Chile. Today it manages the optical observatories of **La Silla and Paranal** (**LSP**, which includes **VLT/VLT-I**), as well as the European participation in the millimetre and sub-millimetre radio observatory **ALMA**. The optical observatory **E-ELT (European Extremely Large Telescope)**, labelled as a "landmark" in the ESFRI landscape and for which construction has begun, will be added to that list. Beyond those three international components, ESO can also be extended further to **a national RI INSTRUM'ESO (*Instrumentation for ESO's large telescopes*)**. Those instrument developments coordinated at national level are indispensable in order to guarantee France's place in the projects in terms of national industrial return. Moreover, they place France at the best scientific level in the European framework thanks to the expertise in the instruments and their data.

More specialised and more accessible, **two VLRI within an international partnership**, the **CFHT** in Hawaii in the optical domain (CA, FR, US) and **IRAM** near Grenoble in the millimeter and sub-millimeter domain (DE, FR, ES), offer unique performance in wide-field imaging, spectropolarimetry and probing of the cold Universe, and supplement ESO's telescopes and space missions.

Two multilateral RIs, the ILT (International Lofar Telescope) radio-telescope network and the **HESS (High Energy Spectroscopic System)** Cherenkov telescope are the precursors of two major international projects listed in the ESFRI roadmap: **SKA** and **CTA**. Today CTA is on the national roadmap as a VLRI project. Note that HESS today and CTA in the future, primarily devoted to high energy astrophysics, are at the interface between astrophysics and particle physics.

The above set of observation infrastructures is completed by **a virtual RI, the Strasbourg astronomical Data Centre (CDS)** dedicated to the dissemination of astronomical data and added value products.

In addition, networking the instrumental platforms the large "ground" and "space" projects makes it possible to optimise their role in the development of those projects and in the implementation of high technology means, with a strong link with the industrial world and the local environment.

Three more targeted international tools must also be mentioned: **JIV-ERIC** for the VLBI and the space-time reference systems (fundamental physics), the ionospheric radars (**EISCAT/EISCAT3D**), and the solar telescope **THEMIS** associated with the project of the future **EST** (**European Solar Telescope**) and three national means: the **Pic du Midi Telescope** (stellar spectro-polarimetry), the **Haute Provence Observatory** Telescope (exoplanet research) and the Nançay **Radio Telescope** (pulsars).

The community also makes use of other research infrastructures, in particular the national and European means for computing and storing for theoretical developments, the numerical simulations and the massive processing of data, and the light lines for laboratory astrophysics. Mention must also be made of the **VIRGO** experiment (gravitational waves and laws of fundamental physics) and **LSST** (opening of the area of the temporally dynamic universe, dark matter and dark energy), carried by particle physics. Astrophysics and particle physics tend to get closer through questions about the unification of the fundamental interactions and the special role of gravitation, astroparticles and very high energies. The area of ultra-high energy neutrinos (**KM3NeT, Ice-Cube**) is another example of this interdisciplinary field.

LIST OF RESEARCH INFRASTRUCTURES ASTRONOMY AND ASTROPHYSICS

TYPE	NAME	FULL NAME	ESFRI
IO	ESO	European Southern Observatory	
	ESO ALMA	Atacama Large Millimeter/Submillimiter Array	
	ESO EELT	European Extremely Large Telescope	
	ESO LSP	La Silla & Paranal Observatory	
VLRI	CFHT	Canada-France-Hawaii Telescope	
VLRI	IRAM	Institute for Radio Astronomy at Millimeter wavelength	
RI	CDS	Strasbourg Astronomical Data Centre	
RI	ESO-INSTRUM	Instrumentation for ESO large telescopes	
RI	*HESS*[1]	*High Energy Stereoscopic System*	
RI	ILT-LOFAR FR	International Low Frequency Radio Array Telescope - LOFAR FR	
Project	*CTA*[2]	*Cherenkov Telescope Array*	*CTA (2008)*

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".

ESO

European Southern Observatory



Type: International Organisation

Headquarters location:
Santiago (CL), La Silla (CL),
le Cerro Paranal (CL), le Cerro Armazones (CL),
plateau de Chajnantor (CL)

Other sites:
Garching, DE

Contact person in France:
Laurent VIGROUX, Denis MOURARD

Stakeholders in France:
CNRS, CEA, ONERA, Observatoire de Paris

Contact in France:
eson-france@eso.org

www.eso.org/public/france

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 2015, Brazil ratified the agreement of accession at the parliamentary level and is waiting for the presidential signature. 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.

SOCIO-ECONOMIC IMPACT

France benefits, like the other ESO members-states, of a fraction of the contracts related to the construction and the operations of the observatories. The most important part of the industrial return at the local and national level lies in the developments phases of the telescopes and of the instruments with a special role in the field of optics.

DATA

Data flow: A few hundred GB/night.

Data storage: After a first automatic pre-treatment on site, the data collected by the telescopes are transmitted by network to Santiago (Chile), then to Garching (Germany) where they are archived.

Accessibility: Archived data in the astronomy standards are put at the disposal of the Principal investigator of the proposal and, at the end of 1 year proprietary period, to anyone who asks. Metadata are also public.

Metadata and auxiliary data are an integral part of the archive, accessible via the directory of the International Virtual Observatory (IVOA).

Presence in data networks: International Virtual Observatory (IVOA).

Operating costs

151.1 M€/year including 24.14 M€ of French contribution

Personnel

730 FTE (no French personnel)

International dimension

Coordinator: Tim de Zeeuw, General Director

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

Website: www.eso.org

ESO ALMA

Atacama Large Millimeter/ Submillimiter Array

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 will be 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%.

SOCIO-ECONOMIC IMPACT

France is strongly involved in the building of ALMA (antennas: Thales Alenia Space, detectors, back-end and correlator: IRAM), as well as in data analysis. The achievement of 25 antennas of 12 m by the European antenna consortium was a technological challenge because of the specifications of mass, of accuracy (pointing at a fraction of arcsecond, surface precision at 25 micron, stability in temperature, wind, etc.).

DATA

Data flow: The data flow is estimated at 200 TB per year in cruise regime, but could reach 500 TB per year.

Data storage: Data are archived and made accessible in a VO (Virtual Observatory) compatible system. The data are transferred from the observing site to Santiago, and then to each of the 3 Alma Regional Centers.

Accessibility: Data are stored in the standard for astronomy with a proprietary period of one year. Metadata and auxiliary data are an integral part of the archive. All the data will soon be available on the directory of the International Virtual Observatory Alliance - IVOA.

Presence in data networks: International Virtual Observatory (IVOA).

Construction costs

—

1,300 M€

Operating costs: 21 M€/year

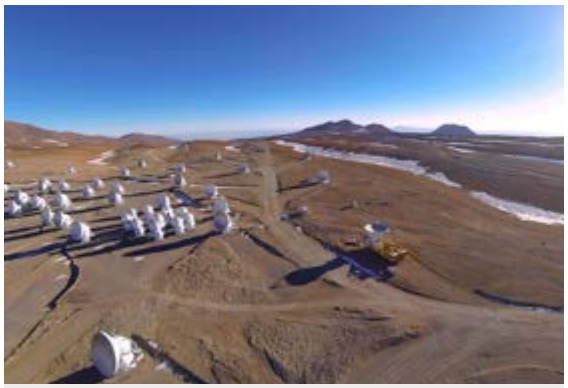
International dimension

ALMA is an instrument of ESO international organisation.

Coordinator: Joint ALMA Observatory (JAO)

Partner countries: ESO consortium, US, JA

Website: www.almaobservatory.org



Type: ESO instrument

Headquarters location:
Chajnantor plateau (CL)

Contact person in France:
Denis MOURARD

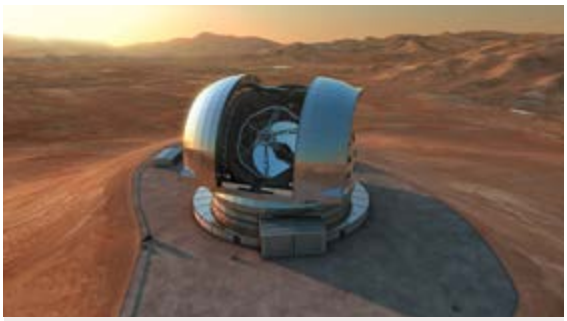
Operation:
2011 (partial network), 2013 (complete network)

Contact in France:
denis.mourard@cnrs-dir.fr

www.eso.org/public/france/teles-instr/alma

ESO E-ELT

European Extremely Large Telescope



Type: ESO instrument

Headquarters location:
Cerro Armazones (CL)

Contact person in France:
Denis MOURARD

Construction:	Operation:
2014	2024

Contact in France:
denis.mourard@cnrs-dir.fr

www.eso.org/public/teles-instr/e-elt

The E-ELT will be the largest telescope in the world (nearly 40 meters in diameter) in the field of visible and infrared observation, more than a hundred times more sensitive than the largest current optical telescopes. It will be able to correct atmospheric distortions and will provide images 15 times more precise than the Hubble Space Telescope (HST).

Scientific objectives:
- direct imaging of planets outside the solar system and search for the origins of life. This objective is central and determines the diameter of the telescope;
- study of the constituents of the universe at all scales: stars, galaxies, clusters of galaxies;
- study of the first objects in the universe: galaxies, black holes, and first breakthrough in the dark ages of the universe.

The E-ELT will be complementary to the very large ground and space observatories operating at other wavelengths in 2020 or beyond: ALMA since 2012 in the millimetre and sub-millimetre domain and LOFAR (2008) and then SKA (2020 +) at greater wavelength, the James Webb Space Telescope (NASA/ESA, 2018), a space infrared telescope of 6.5 m in diameter, and Athena (ESA, 2028), a space X-ray telescope.

A coordination has been set up by the CNRS/INSU to manage the French involvement in the development of the focal instruments.

The E-ELT was posted as a priority during the last two symposia of prospective in astronomy in France (2009 and 2014). It is also a priority of the European astronomical community (first priority of ASTRONET).

SOCIO-ECONOMIC IMPACT

For the phase B contracts of E-ELT, the French industrial return was 21% (12 M€ for 57 M€ in total). The industrial return expected for the construction of the E-ELT is 150-200 M€ (segments of the M1 mirror and polishing of the M2 mirror (SAGEM), petals of the M4 mirror (SAGEM).

The contribution to the instruments and to the Adaptive Optics system, which is attributed to the laboratories, and ultimately to industry, of the order of 15 M€, is to be added.

DATA

Data flow: Of the order of a few hundreds GB per night.

Data storage: The data will be stored in the standard of astronomy. Metadata and ancillary data will be an integral part of the archive.

Accessibility: See ESO general factsheet.

Presence in data networks: International Virtual Observatory (IVOA).

Construction costs

1,104 M€. Phase 1 is estimated at 997.5 M€ and phase 2 at 106.5 M€.
Operating costs: 45 M€/year including ESO personnel.

International dimension

E-ELT is an instrument of ESO international organisation.

ESO LSP

La Silla & Paranal Observatory

The scientific programs covered by the VLT/VLT-I are very diverse, from planetary science to cosmology. The 3.60 m telescope is mainly dedicated to exoplanets.

The Very Large Telescope (VLT) is a network of 4 telescopes of 8 m in diameter which can be operated either individually or simultaneously in interferometric mode (VLTI), or combined with 4 auxiliary telescopes of 1.80 m in diameter.

Each 8 m telescope has 3 focal instruments for individual use. The light received by the 8 m telescopes and the auxiliary telescopes can be coherently recombined in interferometric mode and analyzed by one of the 3 instruments available today, or in incoherent mode when the ESPRESSO instrument will be available (For the focal instruments of the VLT/VLT-I see the INSTRUM-ESO factsheet).

In interferometric mode, the spatial resolution is that of a telescope of 200 m in diameter, corresponding to the greatest separation between the telescopes. The VLT is unique in the world, not because of the size of the telescopes, because there are more than a dozen 8-10 m-class telescopes in the world, but because of the ability to couple in interferometric mode four 8 m-class telescopes, which provides access to imaging possibilities which cannot be provided with only 2 telescopes (e.g. the Keck in Hawaii). Moreover, the quality of the site, the reliability of operations, and a very comprehensive set of focal instruments make the VLT the best global observatory for astronomy in the visible and near-infrared.

SOCIO-ECONOMIC IMPACT

France benefits, like the other ESO members-states, of a fraction of the contracts related to the maintenance of the VLT, but this fraction is limited, taking into account the location of the VLT. This concerns especially the optical devices (including adaptive optics) and the opto-mechanical devices. For the instrumentation, see the factsheet INSTRUM-ESO.

DATA

Estimation du flux de données: A few hundred GB/night.

Data storage: See ESO general fact sheet.

Accessibility: See ESO general fact sheet.

Presence in data networks: International Virtual Observatory.

Operating costs

—

40.4 M€/year

International dimension

Silla-Paranal observatory is one of the instruments of ESO international organisation.



Type: ESO instrument

Headquarters location:
Cerro Paranal (CL), La Silla (CL)

Contact person in France:
Denis MOURARD

Operation:

1998

Contact in France:
denis.mourard@cnrs-dir.fr

www.eso.org/sci/facilities/lpo.html

CFHT

Canada-France-Hawaii Telescope



Type: VLRI, Limited company under American law

Headquarters location:
Hawaii, USA

Contact person in France:
Pierre-Olivier LAGAGE

Construction:	Operation:
1974	1977

Maintenance:
SPIRou instrument reconsidered for 2017

Stakeholders in France:
CNRS, Paris DIM-ACAV, Idex Toulouse, Univ. Joseph Fourier, AMU

Contact in France:
pierre-olivier.lagage@cea.fr

www.cfht.hawaii.edu/fr/public

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

The infrastructure is made of a 3.6 m telescope and a suite of performant 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 (in 2017) SPIRou (an ultra-stable spectro-polorimeter in the Infrared).

The telescope time is distributed after the release of 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 over 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 boreal sky with the MEGACAM camera to study galaxies and to complement the space observations made with ESA's Euclid mission;
- the study of exoplanets, from spectroscopy observations in the Infrared wavelength domain with the SPIRou instrument.

SOCIO-ECONOMIC IMPACT

An innovative instrumentation at the cutting edge of technology is necessary and often requires forefront R&D studies. For example, one can quote the Hawaii 4RG detector array for the SPIRou instrument or the large gratings for the echelle spectrographs, such as those of ESPaDons and SPIRou.

DATA

Data flow: 30 TB per year.

Data storage: Canada Astronomy Data Center (CADC). The data from the large CFHTLS program have been analyzed at the TERAPIX center at IAP (http://terapix.iap.fr).

Accessibility: Data accessible in the international FITS format (IVOA directory at CADC) at the end of the proprietary period.

Presence in data networks: International Virtual Observatory Alliance (IVOA)

Construction costs

SPIRou: 4.1 M€ including 1.8 M€ of French contribution
Operating costs: 7.2 M$, including 3.2 M$ of French contribution

Personnel

5.2 M$, no French personnel

International dimension

Coordinator: Douglas Welch

Partner countries: FR, CA, US

Website: www.cfht.hawaii.edu

IRAM

Institute for Radio Astronomy at Millimeter wavelength

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 à 350 GHz).

IRAM instruments provide very versatile observation possibilities in the (sub)millimeter domain, one of the key wavelength domain in modern astrophysics. The science topics include in particular the study of the solar system (planetary atmospheres, comets), stars and protoplanetary disk formation, late star evolution phases, chemical and physical properties of the interstellar medium, nearby galaxies, as well as galaxy formation at high redshift and the related cosmological studies.

The two IRAM observatories are:
- a 30-m antenna located on the Pico Veleta, in the Sierra Nevada, near Granada (Andalousia, Spain);
- an interferometer composed of 7 15-m antennas (in 2015), located on the Plateau de Bure, in the Devoluy massif (French Alps); it is currently being upgraded, and it will gradually include 12 antennas in 2019 (NOEMA project).

IRAM also hosts dedicated laboratories and teams, covering many technical and scientific needs: receivers, super-conducting elements, electronics, high-precision mechanics, control software, data reduction software, etc.

SOCIO-ECONOMIC IMPACT

A large fraction of the spending for NOEMA is the purchase of high-tech components, whose development requires important R&D efforts. Specific development projects are in place with several companies in the domains of high-speed electronics, cryogenic, high-precision mechanics, or integrated control systems.

DATA

Data flow: NOEMA data rate: 400 GB/day (standard observing mode), up to 3 TB/day for the most complex observing modes.

Data storage: Data archived at IRAM.

Accessibility: Data immediately available to the groups that have proposed the observations. Data accessible to the whole community after a proprietary period (18 months up to 3 years).

Presence in data networks: CDS and IVOA

Operating costs
—
11 M€/year including personnel costs

Personnel
—
120 FTE including 90 in France

International dimension

Coordinator: Karl Schuster

Partner countries: FR, DE, ES

Website: www.iram-institute.org



Type: VLRI, Limited company under French law

Headquarters location:
Grenoble, FR

Other sites:
Bure plateau, Grenade (ES), Pico Veleta (ES)

Head of the Infrastructure/ Contact person in France:
Karl-Friedrich SCHUSTER

Construction:
1979

Operation:
1986 (Pico Veleta), 1990 (Bure plateau)

Maintenance:
NOEMA project: increase from 6 to 12 antennas from 2014 to 2019

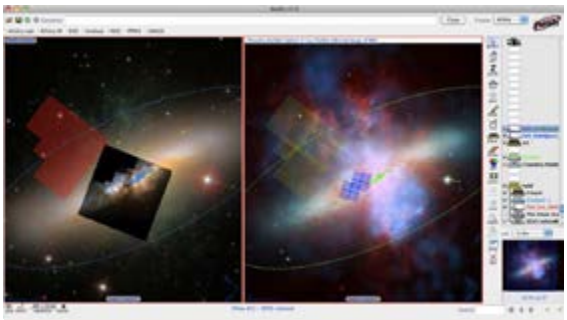
Stakeholders in France:
CNRS (FR, 47%), Max-Planck-Gesellschaft (DE, 47%), Instituto Geográfico Nacional (ES, 6%)

Contact in France:
schuster@iram.fr

www.iram-institute.org

CDS

Strasbourg Astronomical Data Centre



Type: RI

Headquarters location:
Strasbourg, FR

Other sites:
Virtual infrastructure

Head of the Infrastructure:
Mark ALLEN

Operation:

1972

Stakeholders in France:
CNRS, Univ. Strasbourg

Contact in France:
mark.allen@astro.unistra.fr

cds.unistra.fr

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 to provide 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; since 2011 the CDS also provides the fastest cross-identification service for very large catalogues.

In 2014, the CDS services managed more than 800,000 queries per day. In this period there were 679 journal citations of SIMBAD, 306 of VizieR and 58 of Aladin (source ADS).

SOCIO-ECONOMIC IMPACT

Collaboration with scientific editors and publishers of academic journals to enrich the links between publications and data. The CDS has published tables from the Astronomy & Astrophysics Journal since 1993.

DATA

Data flow: Data flow: The essence of the CDS is to provide services allowing to access and use data. Those data include those made available by the CDS itself, but also data from the archives of the observatories which are made accessble via links and via the interoperability of the Virtual Observatory.

Data storage: Approximately 1 PB.

Accessibility: Free access to the data and services.

Presence in data networks: The CDS services are available via the Virtual Observatory. The CDS is a member of the ICSU World Data System (www.icsu-wds.org), and the CDS has been certified by the Data Seal of Approval (www.datasealofapproval.org/en).

Operating costs

0.7 M€

Personnel

30 FTE

International dimension

Since 2006 the CDS coordinates the European Virtual Observatory Euro-VO. Euro-VO is a member of the International Virtual Observatory Alliance (IVOA).

Coordinator: IVOA (International Virtual Observatory Alliance).

Partner countries: Euro-VO: FR, DE, ES, IT, UK

IVOA: ZA, DE, AR, AM, AU, BR, CA, CL, CN, ES, FR, HU, IN, IT, JP, UK, RU, UA, US

Website: www.ivoa.net

INSTRUM-ESO

Instrumentation for ESO's large telescopes

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 IR) have been successfully integrated at Paranal in 2014 and 2015.

France is today involved in both instruments of 2nd generation of the VLT-I as leader of one of them and as co-leader of the other one. It is respectively MATISSE, which, by recombination of the 4 telescopes in the mid-IR (3-10 µm), will enable obtaining images with a resolution of 10 to 20 milli-arcsecond with main objectives on star formation, and GRAVITY that will have an astrometric accuracy of 10 micro-arcseconds on small objects (tests of general relativity and study of extrasolar planets). GRAVITY will be installed at Paranal from fall 2015 and MATISSE from mid-2016. France is also involved in the realization of MOONS, a wide field multi objects spectrograph for galactic, extragalactic and cosmological investigations.

The preparatory work on the future E - 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 Adaptive Optics (MAORY); its ambition is also to be a leader of the MOSAIC instrument for which a complementary phase A study is planned in 2016/2017.

SOCIO-ECONOMIC IMPACT

The sectors which are mainly concerned are those of advanced optics (innovative components, specific surface treatments, concepts and components of active and adaptive optic systems), visible and infrared detectors (high sensitivity, fast reading, large detection surface), real time calculators, etc.

DATA

Presence in data networks: The astrophysical data collected by the instruments are handled by ESA (see ESO general factsheet).

Operating costs
—
20 M€/year

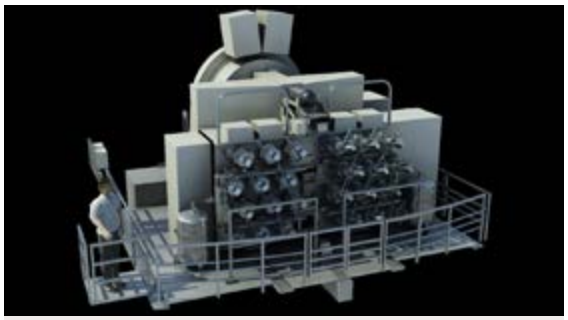
Personnel
—
35 FTE

International dimension

The infrastructure contributes to the realisation of ESO instruments. The national coordination interacts directly with ESO as well as with the network of development platforms under construction.

Coordinator: ESO (International Organisation)

Website: www.eso.org



Type: RI

Headquarters location:
Paris, FR

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Denis MOURARD

Construction:	Operation:
2015	2015

Stakeholders in France:
CNRS, CEA, ONERA

Contact in France:
denis.mourard@cnrs-dir.fr

www.eso.org/public/france/about-eso

HESS

High Energy Stereoscopic System



Type: RI

Headquarters location:
Khomas Highlands, Namibie

Head of the Infrastructure:
Mathieu DE NAUROIS

Operation:

2003

Maintenance:
The cameras of four telescopes are at the moment under complete upgrade. CTA project is a successer of HESS.

Stakeholders in France:
CNRS, CEA

Contact in France:
denauroi@in2p3.fr

When entering the atmosphere, cosmic 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 of large collecting surface, installed inside a square of 120 m side. This array allows identifying the origin and the energy of each individual gamma ray. The network consists in 4 telescopes of 12 m diameter each and a 5th very large telescope of 28 m diameter inaugurated in 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, and to improve the overlap with the 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.

SOCIO-ECONOMIC IMPACT

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

DATA

Data flow: 1 PB, growing by 150 to 200 TB per year.

Data storage: Data are first stored on site, and then sentas magnetic tapes (in two distinct copies) to France (in the CNRS-CEA computing centre of Lyon) and to Germany (Heidelberg).

Accessibility: Data belong to the collaboration. To date there is no "public" tool allowing to access the data and analyse them. Data are stored using the ROOT (https://root.cern.ch) format, developed at CERN and widely used in the High Energy Physics community. Data access uses standardised protocols developed by the same community (xrootd, hpss, LFC...).

Presence in data networks: CNRS-CEA computing center in Lyon, EGI distributed computing grid.

Construction costs

20.5 M€ including 6.5 M€ of French contribution

Operating costs:
2 M€/year including 0.5 M€ of French contribution

Personnel

2 FTE

International dimension

Coordinator: Mathieu de Naurois, FR

Partner countries: FR, DE, NA, ZA, UK, IE, AT, PL, CZ, SE, AM, AU, JP

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

ILT-LOFAR FR

International Low Frequency Radio Array Telescope - LOFAR FR

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 antennae. Its main scientific application fields are cosmology, galaxy clusters, cosmic magnetic fields, cosmic rays, the Sun, planets and the variable universe (pulsars, black holes and high-energy sources, planets and exoplanets). Each international station includes 96 low-frequency antennae (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).

NenuFAR will strongly increase the sensitivity and other characteristics, such as improved calibration; the antennae 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 antennae) and as a stand-alone instrument with a specific scientific programing.

DATA

Data flow: 2 TB/day (100 times more before compression).

Data storage: LOFAR Long-Term Archive (LTA): a unique and uniform interface gives access to data collected by the various ILT equipments, and stored in various places (Amsterdam, Groningen, Jülich and a new center in Poland).

Accessibility: All the products of calibrated data from ILT observations remain the property of the ILT, as well as all data produced by the ILT pipeline. The ILT grants the working group (applicants and PI) an exclusive access time of 1 year, after which the data become public. Interferometric data are stored in the Measurement Set data format used in particular for the EVLA. Beam-formed and single station data are stored in HDF5 format. LOFAR participates, as a pathfinder of SKA, in the Work Package Data Access, Discovery and Interoperability of the European cluster ASTERICS, with the aim of optimizing the access to the Virtual Observatory.

Presence in data networks: LOFAR, as a SKA pathfinder, participates to the Work Package "Data Access, Discovery and Interoperability" of the European cluster ASTERICS, with the objective to optimize the access to the data through the Virtual Observatory.

Operating costs

—

0.112 M€ (FR)

Personnel

—

LOFAR: 0.6 FTE; NenuFAR 4 FTE during construction phase

International dimension

French participation at the international research infrastructure ILT acknowledged as "pathfinder" of future SKA project.

Coordinator: ASTRON (NL)

Partner countries: NL, DE, UK, FR, SE, PL, IE

Website: www.lofar.org



Type: RI, Foundation under Netherland's law

Headquarters location:
Nançay, FR

Other sites:
Other stations: NL (37), DE (6), UK (1), SE (1), PL (3), IE (1)

Head of the Infrastructure:
Michel TAGGER, Philippe ZARKA

Construction:	Operation:
2010	2011

Maintenance:
2016: NenuFAR extension

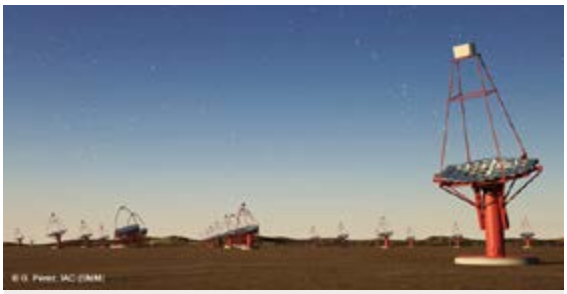
Stakeholders in France:
CNRS, Observatoire de Paris, Univ. Orléans

Contact in France:
michel.tagger@cnrs-orleans.fr

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

CTA

Cherenkov Telescope Array



Type: Project, GmbH

Headquarters location:
Paranal (CL), La Palma (ES)

Head of the Infrastructure:
Jürgen KNODLSEDER

Construction:
GmbH creation in 2014, start of construction considered in 2016-2017

Operation:
2018-2019

Maintenance:
Upgrade every 10 ans

Stakeholders in France:
CEA, CNRS

Contact in France:
jurgen.knodlseder@irap.omp.eu
tabegg@lsw.uni-heidelberg.de

www.facebook.com/CTA.France

Cherenkov telescopes detect the gamma-ray photons by measuring the faint flashes of the Cherenkov light that is emitted by the electromagnetic cascades created from the interaction of the gamma-ray photons with the Earth atmosphere. Following the success of the second generation of Cherenkov telescopes for very high energy gamma astrononomy (and especially H.E.S.S., which mainly results from a French-German collaboration), CTA naturally expands on existing telescopes by proposing to implement about a hundred Cherenkov telescopes distributed in two networks.

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. Telescope networks of different sizes will allow to cover an extended energy range, and to extend the observations to lower energies so as to overlap with the energy range covered by Nasa's Fermi satellite launched in 2008 and operational for 5-10 years.

SOCIO-ECONOMIC IMPACT

CTA creates opportunities for technology transfers towards industry. For example, the development of medium-size telescope mirrors by CEA/IRFU and the telescope archesbuilding led to a technology transfer towards the SME Kerdry and a partnership with SME LORIMA in the context of a partnership with the Brittany region.

DATA

Data flow: 6 GB/s during about 1,300 hours of annual observing time, and about 3 PB/year after reduction, hence about 90 PB during the assumed CTA lifetime of 30 years. After event reconstruction and background rejection, the annual data volume is reduced to < 1 TB.

Data storage: The CTA data will be archived in parallel way in several data centers. Access to the archives will be possible both via a web interface and via the directories of the International Virtual Observatory (IVOA).

Accessibility: Data in open access in the international format FITS after about one year of exclusivity period. "Open source" exploitation software will be made available.

Presence in data networks: It is envisioned to use existing data centres to process and store the CTA data. The involvement of the CEA-CNRS Computing Center in Lyon is under consideration.

Construction costs

Estimated 300 M€
including 50 M€ of French contribution (considered)
Operating costs: 20 M€

Personnel

71.8 FTE in France

International dimension

French participation to an ESFRI research infrastructure (gGmbH in Heidelberg, DE)

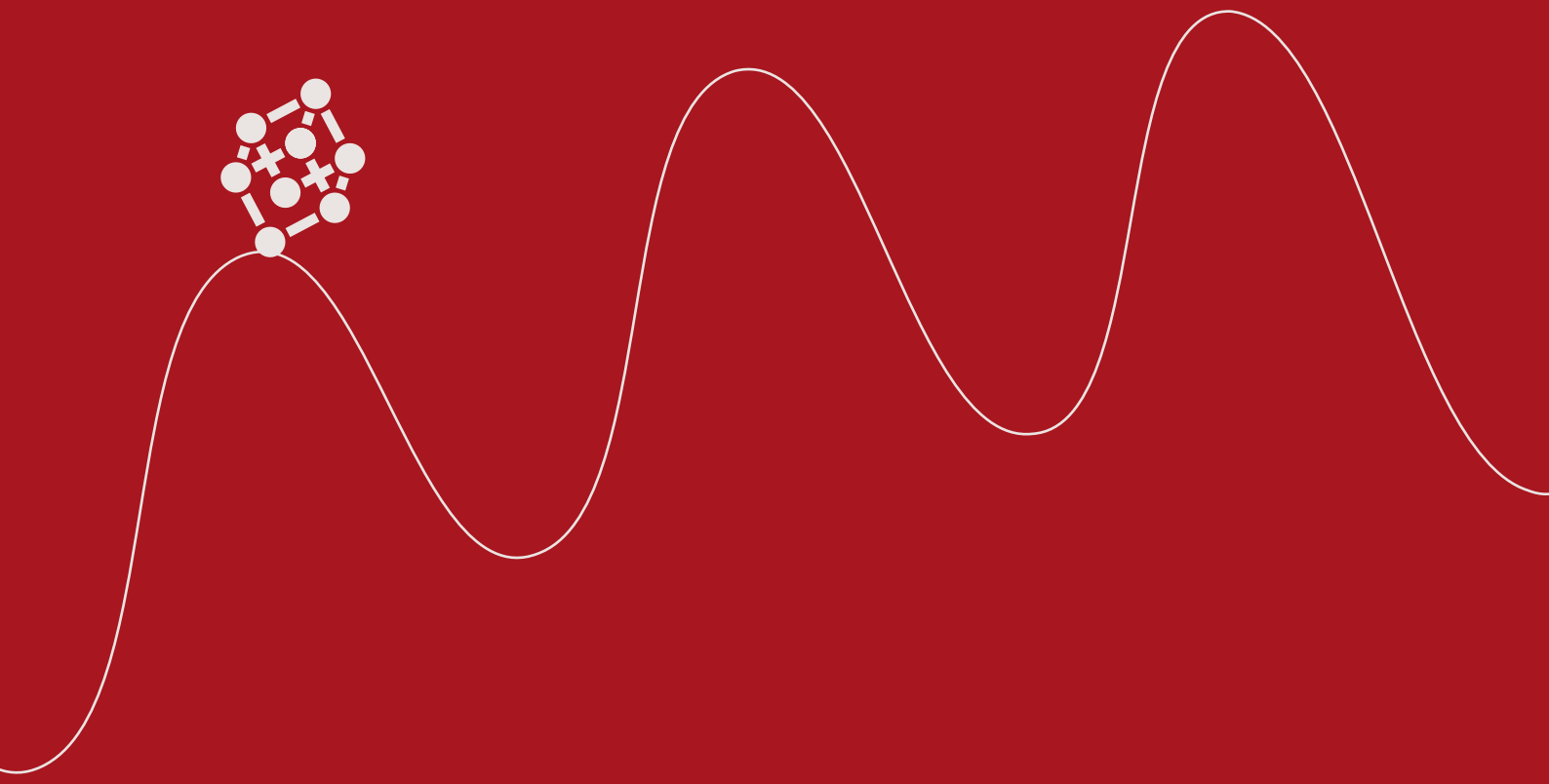
Coordinator: Président: G. Vettolani, IT

Partner countries: DE, ES, IR, CZ, UK, CH, Associate members: NL, SA, SE, FR (considered)

Website: www.cta-observatory.org



NUCLEAR AND HIGH-ENERGY PHYSICS



Nuclear and High-Energy Physics

The major research infrastructures in these scientific fields meet the needs of the community of physicians who have for ambition to study the final constituents of the matter. These infrastructures concern the Themed Coordination Committee VLRI created by the CEA and the CNRS. In nuclear physics, French scientists are mostly committed, in France and in Europe, in heavy ion accelerator complexes located on the sites of GANIL, in Caen, and GSI in Darmstadt in Germany, delivering stable and radioactive beams. These sites are as such designed to shelter, by 2017-2025, the spearheads in European nuclear physics research, SPIRAL2 and FAIR.

The objectives of SPIRAL2 were reoriented in order to make use of Equipex S3 and DESIR as quickly as possible, in a particularly tight budget context. SPIRAL2 will also be a source of fast neutrons (14 MeV) among the best successful in the world for the next ten years. With regards to FAIR, despite the delay in the project, it will be unique through the importance of the scientific fields covered, through the variety of the accelerated beams (heavy ions, antiprotons), its complementarity with SPIRAL2 for radioactive beams, and with the experiments of the LHC at CERN and of RHIC and JLAB in the United States in hadronic physics. In 2016, SPIRAL2 and FAIR will leave the ESFRI roadmap, acquiring ESFRI "Landmark" status. Today, financing for phase 2 of SPIRAL 2 is not acquired. This will probably be thanks to the opening of GANIL to other countries.

After the discovery of Higgs boson (Nobel prize in 2013), the detailed study of its properties as well as the coherency tests of the standard model and the search for physical signals beyond the standard model are the top priorities of the discipline. The European strategy for particle physics, approved in 2013 by the council of CERN, subsequently announced that the top priority is the maximum use of the LHC with a first phase of improving the detectors which will have to be put into service around 2018-2019, and a second high brightness phase which will start around 2026. Data collection at the LHC should continue until in 2035-2038.

In light of the time required to design new infrastructures in particle physics, develop the required technologies and carry out their construction, CERN has launched a study for the design of a future complex of accelerators, the "Future Circular Collider" (FCC) which could accommodate colliders with a circumference of 100km and the construction of a linear collider is being discussed in Japan.

The discovery of neutrino oscillations (Nobel prize in 2015) and more recently the measuring of the last mixing angle 13, highlights the basic questions concerning the hierarchy of the masses of neutrinos and the violation of CP symmetry in the neutrino sector. In France, the ORCA project, based on measuring atmospheric neutrinos follows the Antares experiment in the Mediterranean, and is deployed in the framework of the international KM3NeT collaboration which also includes a second site near Catania in Italy devoted to neutrino astronomy. Note that the French teams are involved in neutrino research projects that make use of other infrastructures in China and in the United States.

Observational cosmology, through in particular the study of fossil radiation, dark matter and dark energy, has obtained spectacular results over the last fifteen years (Nobel Prize in 2011, the Planck mission). The flagship projects for measuring dark matter and dark energy, currently in the construction phase, are LSST on the ground, and Euclid (ESA mission) in space. HESS and in time the CTA project allow for indirect observations of dark matter.

The discovery of the gravitational waves, announced in February 2016, by collaborations LIGO (USA) and VIRGO from data collected by LIGO, will have a considerable impact and opens a new window on the Universe. The re-commissioning of the VIRGO antenna near Plisa (Advanced Virgo), after a substantial programme of improvements should allow other direct detections in the next few years.

LIST OF RESEARCH INFRASTRUCTURES NUCLEAR AND HIGH-ENERGY PHYSICS

TYPE	NAME	FULL NAME	ESFRI
IO	CERN-LHC	European Organization for Nuclear Research - Large Hadron Collider	
VLRI	EGO-VIRGO	European Gravitational Observatory - VIRGO	
VLRI	FAIR	Facility for Antiproton and Ion Research	FAIR (2006)
VLRI	GANIL-Spiral2	Grand National Heavy Ion Accelerator (GANIL), Radioactive Ion Production System in Line of 2nd generation (SPIRAL2)	Spiral2 (2006)
RI	*HESS*[1]	*High Energy Stereoscopic System*	
RI	KM3NeT	Kilometre Cube Neutrino Telescope	KM3NET (2006, 2016)
RI	LSST	Large Synoptic Survey Telescope	
Project	*CTA*[2]	*Cherenkov Telescope Array*	*CTA (2008)*

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

CERN – LHC

European Organization for Nuclear Research - Large Hadron Collider



Type: International Organisation

Headquarters location:
Geneva, CH

Contact person in France:
Ursula BASSLER, Anne-Isabelle ETIENVRE

Construction:

1954

Operation:
CERN: 1957
LHC: 2008

Maintenance:
LHC Phase I: 2019
LHC Phase II: 2027

Stakeholders in France:
CEA, CNRS

Contact in France:
ursula.bassler@cnrs-dir.fr
anne-isabelle.etienvre@cea.fr

www.lhc-france.fr

home.cern/fr

CERN is leading particle physics in Europe and operates with the LHC the most important, global infrastructure in the particle physics domain. CERN pursues also research programs in nuclear physics, neutrino physics and an accelerator and instrumentation R&D program. For the needs of the HEP community, CERN operates computing infrastructures and envisages playing a key role in the structuration of numeric infrastructures in Europe.

LHC is currently the particle collider with the highest energies, and reached in 2015 its nominal energy.

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. 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.

SOCIO-ECONOMIC IMPACT

Orders placed with French firms amounted to 69.5 MFCH for services and 78.6 MFCH for supplies, corresponding to respective return coefficients of 2.86 and 1.57. EDF, ALSTOM, AIR LIQUIDE and THALES also participate in advanced innovative studies conducted at CERN.

DATA

Data flow: 60 PB of data/year (80 PB/year in 2025).

Data storage: The data are distributed on a worldwide comuting grid, with about 10% of its capacities in France.

Accessibility: CERN undertakes an open access policy to the data, which is already partially put in place for the CMS experiment.

Presence in data networks: WLCG (wolrd-wide LHC Computing Grid) and LCG-France.

Construction costs

LHC: 5.2 Md€
Upgrade LHC:
Phase I: 20 M€
(French contribution),
Phase II: 50 M€ (French contribution, not decided yet)

Operating costs:
CERN: 150 M€
(French contribution)

Personnel

510 FTE

International dimension

HL-LHC, ESFRI Landmark

Coordinator: Fabiola Gianotti, General director

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

Website: home.cern/fr, www.lhc-france.fr

EGO-VIRGO

European Gravitational Observatory-VIRGO

The French Italian EGO consortium, with the Virgo collaboration, builds and manages the giant interferometer VIRGO for observing gravitational waves. Expected during events on celestial bodies, these waves slightly bend the space-time, according to the theory of general relativity.

The Advanced Virgo detector is a highly improved version of the 3 km long Virgo interferometer, designed to measure tiny variations of distance (10-19 m) between its hanging mirrors, induced by the passage of a gravitational wave. VIRGO works with LIGO [Laser Interferometry Gravitational-Wave Observatory] in the USA which has, very recently, performed the first detection of gravitational waves. LIGO and VIRGO entered phase of improvement in 2010-2011. Concerning Advanced Virgo, these improvements concern the laser, the mirrors, the size of the beam, the system of thermal compensation..., and aim 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 detector of second generation will allow the detection of several sources of gravitational waves per year (Supernova, coalescence of binary systems of neutron stars and/or black holes). Germany and the UK have built the GEO600 antenna less sensitive. Japan built the underground Kagra antenna.

SOCIO-ECONOMIC IMPACT

The construction of the interferometer induces innovations and R&D in the field of laser (agreements with Eolite and then ALS), coating, metrology...

DATA

Data flow: more than 500 TB of raw data per year and 20 TB/year of reduced data.

Data storage: EGO owns midsize computing facilities dedicated to short/mid term storage and analysis.

Accessibility: The LIGO and Virgo data are recorded in a joint database hosted by LIGO.

Construction costs

—

151 M€ + 23.8 M€ Advanced Virgo including 7 M€ of French contribution

Operating costs: 9 M€ including 4.5 M€ of French contribution

Personnel

—

60 FTE

International dimension

Coordinator: Federico Ferrini, Director

Partner countries: FR CNRS (50%), IT INFN (50%), NL NIKHEF(in-kind)



Type: VLRI, Company under Italian law

Headquarters location:
Cascina, IT

Contact person in France:
Benoît MOURS

Construction:	Operation:	Maintenance:
1996	2003	2011-2016

Stakeholders in France:
CNRS

Contact in France:
benoit.mours@lapp.in2p3.fr

EGO: www.ego-gw.it

Virgo: wwwcascina.virgo.infn.it

FAIR

Facility for Antiproton and Ion Research



Type: VLRI, GmbH

Headquarters location:
Darmstadt, DE

Contact person in France:
Patricia ROUSSEL CHOMAZ, Fanny FARGET

Construction:	Operation:
2013	2022

Stakeholders in France:
CEA, CNRS.

Contact in France:
patricia.roussel-chomaz@cea.fr
ffarget@admin.in2p3.fr

www.fair-center.eu

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. An ensemble 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

Data flow: More than 30 PB/year.

Accessibility: The data are reusable by other scientists, depending on the agreement of collaboration that obtained the data.

Presence in data networks: The Tier0 machine will be the core of the FAIR HPC network, with 1Tb/s connexion to the HPC systems of the neighboring universities. Remote systems will be accessible via the grid and cloud technologies.

Construction costs

1.357 M€ including 2.7% of French contribution
Operating costs: Estimated at 240 M€ including 2% of French contribution

Personnel

60 FTE

International dimension

FAIR ESFRI Landmark

Partner countries: FR CEA, CNRS (2.7%), DE (69.89%), Ru (17.65%), IN (3.57%), PL (2.35%), RO (1.18%), SI (1.19%), FI (0.5%), SE (0.99%), UK associate member.

Website: www.fair-center.eu

GANIL-SPIRAL2

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

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, 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 40 MeV, 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.



SOCIO-ECONOMIC IMPACT

GANIL is a structuring element with:
- establishment on its campus of CIMAP, CYCERON and CURBE laboratories, and the CYCLOPHARMA company and a hadrontherapy center: ARCHADE;
- creation of 30 start-ups via Normandie Incubation;
- 1 technology transfer (Pantechnik company specializing in ion sources). 1-2 patents/year are filed;
- participation in Nucléopolis.

DATA

Data flow: 5-10 TB of data/year which will reach 200 TB to 800 TB in 2017

Data storage: Data is stored on a local server at GANIL with a capacity of 200 TBytes.

Accessibility: The Data are available during experiments at GANIL, and for 3 to 6 months depending on experience.

Presence in data networks: RENATER

Construction costs

GANIL: 911 MF (1999) + SPIRAL2 phase 1+: 128 M€
Operating costs: 14 M€

Personnel

270 FTE

International dimension

Spiral 2 ESFRI Landmark.

Type: VLRI, Limited company under French law

Headquarters location:
Caen, FR

Head of the Infrastructure:
Florent STALEY

Construction:	Operation:
1976	1983

Maintenance:
2010-2016: Spiral2 Phase 1+

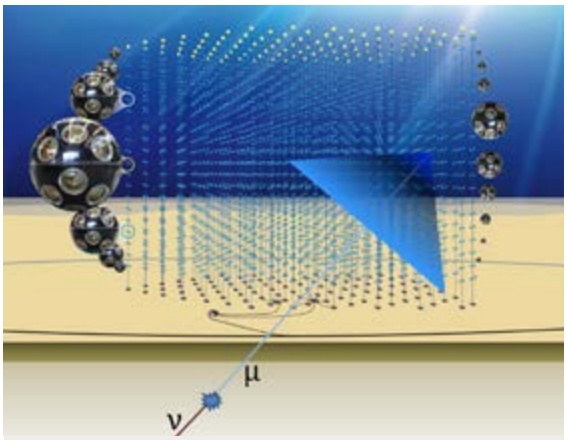
Stakeholders in France:
CEA, CNRS

Contact in France:
accueil@ganil.fr

www.ganil-spiral2.eu

KM3NET

Kilometre Cube Neutrino Telescope



Type: RI

Headquarters location:
Toulon, FR; Capo Passero, IT

Contact person in France:
Paschal COYLE

Construction:

2014

Operation:
2017: 7 lines in France, 24 lines in Italy

Maintenance:
2017-2020: KM3NeT 2.0 upgrade on sites: France (115 lines), Italy (230 lines)

Stakeholders in France:
CNRS, AMU, Univ. Paris 7, Univ. Strasbourg, Univ. Clermont-ferrant, Univ. Lyon, UTLN, OCA, Univ. Paris Sud

Contact in France:
coyle@cppm.in2p3.fr

www.km3net.org

KM3NeT is a 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 after their passage through the Earth. 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) optimised 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 2,500 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. For 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.

The major goals of KM3NeT are the determination of the neutrino mass hierarchy and the discovery and study of astrophysical neutrino sources. The infrastructure is also a unique deep-sea marine observatory providing important synergetic opportunities with the Earth, Sea and environment science communities.

These deep-water permanent infrastructures offer important synergy opportunities with the communities of sciences of Earth, Sea and Environment. At the World level, there is no other infrastructure of this type.

SOCIO-ECONOMIC IMPACT

Many patnerships with industry to develop and construct the infrastructure (Alcatel, Alseamar, Comex, CREDAM, Cybernetix, Degreane, ECA, Euroceanique, Foselev Marine, iXSurvey, iXSea, Nortekmed, Osean, Orange Marine, etc.).

Creation of a startup PowerSea to develop innovative systems and electro-optic connectors for the field of deepsea connectivity. 1 patent awarded.

DATA

Data flow: 8 Tb/year with 31 lines and 106 TB/year for 115 lines.

Data storage: Stockage at the Lyon computing center (IN2P3/CEA).

Accessibility: Data will be public after a two-year period. Environmental data immediately accessible.

Presence in data networks: Platform Mistrals SEDOO (mistrals.sedoo.fr/MEUST)

Construction costs

Phase 1: Infrastructures + 31 lines = 31 M€
Phase 2.0: 345 lines 120 M€
Phase 3: 660 lines 220 M€
Operating costs:
1 M€/year (FR: 0.4 M€, IT: 0.6 M€)

Personnel

25 in France

International dimension

KM3NeT ESFRI Landmark

EMSO: European Multidisciplinary Seafloor and Water Column Observatory

Partner countries: KM3NeT: CY, ES, FR, DE, EL, IE, IT, MA, NL, PL, RO, UK / EMSO: ES, FR, DE, EL, IE, IT, NL, RO, UK, SE, NO, PT, TR

LSST

Large Synoptic Survey Telescope

The Large Synoptic Survey Telescope (LSST) is a large telescope under construction on the Cerro Pachón in Chile since 2014. It will start its observation program in 2022. It has a compact and unique design with 3 mirrors (8.4 m, 5 m and 3.4 m), leading to a very large extent (319 m^2 deg^2): 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.

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 planed large space survey for dark energy study, like the one that will be performed by the Euclid Satellite (ESA project).

SOCIO-ECONOMIC IMPACT

The technical and scientific challenge provided by the construction of LSST, will generate in France innovations in CCD and CCD electronic readout, in precise Optical metrology, and in data base and data processing in the big data Framework associated to LSST.

DATA

Data flow: 15 TB/night

Data storage: Stockage at IN2P3 computer center in Lyon (CC-IN2P3).

Accessibility: Available by researchers through data servers and in some cases by the general public.

Construction costs

—

625 M€ (US) + French contribution camera 14.4 M€

Operating costs: 0,100 M€/year of French contribution during construction

Personnel

—

26 FTE

International dimension

Partner countries: USA, FR, Chili; **Countries participating in exploitation:** USA, FR, CL, AU, BR, CN, HU, IN, RS, ZA, UK



Type: RI, Company under American law

Headquarters location:
Cerro Pachon, Chili

Contact person in France:
Pierre ANTILOGUS

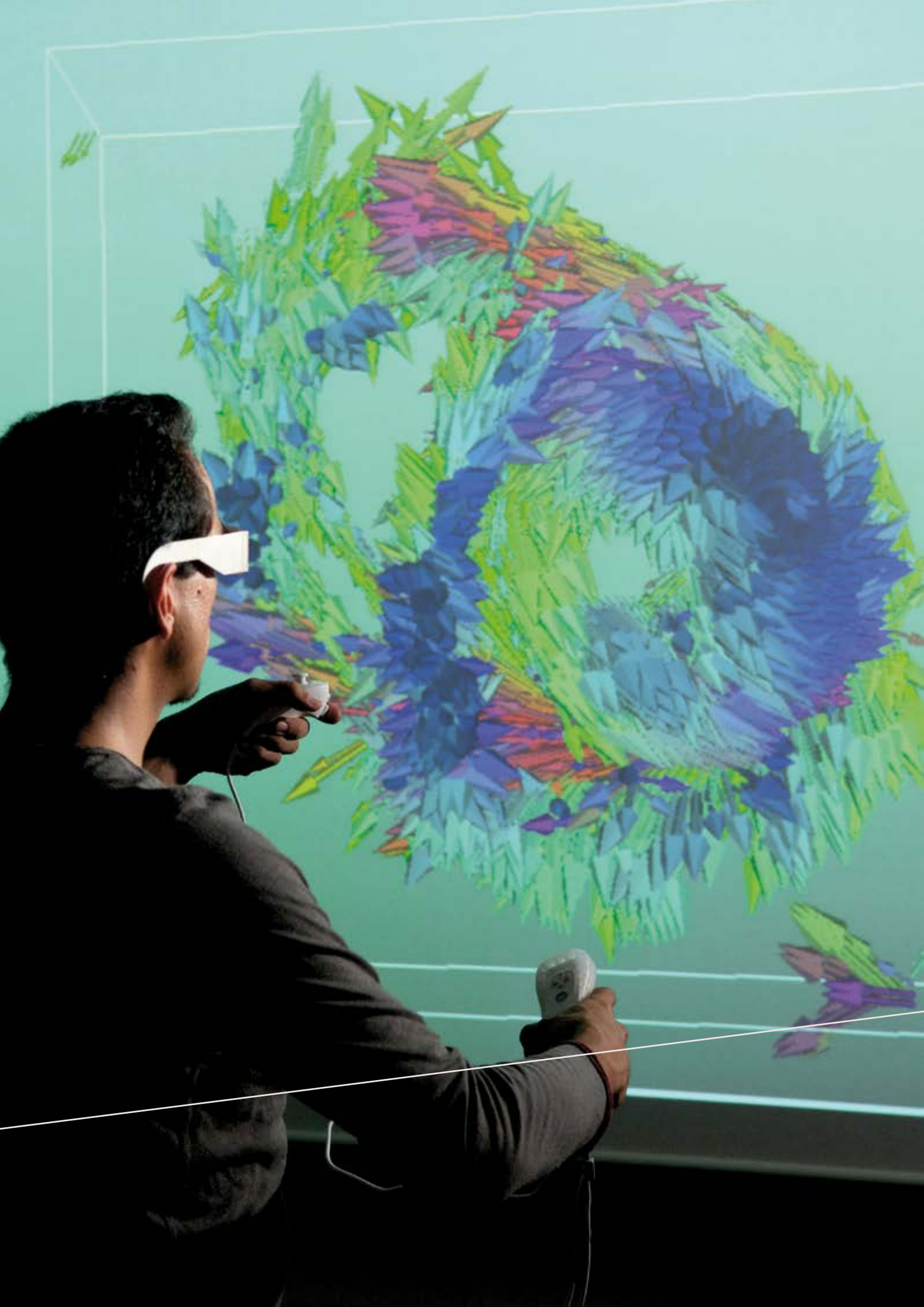
Construction:	Operation:
2014	2022

Stakeholders in France:
CNRS

Contact in France:
p.antilogus@in2p3.fr

lsst.in2p3.fr

lsst.org



DIGITAL SCIENCES AND TECHNOLOGIES; MATHEMATICS

Digital sciences and technologies; Mathematics

The digital world is changing at a substantial speed. It is experiencing an exponential progression in terms of capacity and ubiquity as a consequence of the advent of new technological systems (such as virtual reality, communicating objects, and sensors). In particular, these systems will become a key element for science in regard to massive amounts of data, with sources of data that are either centralised (large instruments in physics, observatories) or distributed (high-speed sequencers, sensor networks). France is adopting a strategy to meet an ever increasing demand in terms of storage, processing, and data communications.

Most digital infrastructures follow a distributed architecture and have the ambition to coordinate a set of actions carried out throughout the country (most often in liaison with European initiatives).

More precisely, the digital infrastructures in the current roadmap consist of four computing infrastructures (GENCI, CCIN2P3, Grid'5000, and France Grilles) and two network infrastructures (RENATER and FIT). The majority of these infrastructures are integrated into European or international infrastructures: GENCI (French component of PRACE), RENATER (French component of GÉANT), France Grilles (French component of EGI), FIT (which is part of the European platform OneLab), and CC-IN2P3 (integrated into the international network of the Worldwide LHC Computing Grid).

From a functional standpoint, the abovementioned infrastructures can be classified into two families. The first family is composed of digital infrastructures for operational needs, which serve all scientific communities at large (GENCI, RENATER, France Grilles, CCIN2P3). The second family includes infrastructures dedicated to mathematical research (GERM) and experimental digital sciences (Grid5000, FIT, RNRVA).

GENCI provides a high-performance computing facility and is organized around three national computing centres of CNRS, CEA, and universities: IDRIS, TGCC, and CINES. As a complement, CC-IN2P3 and France Grilles provide distributed facilities dedicated to processing and storing large amounts of data.

RENATER provides research and high education institutions with a high-speed and secured communications network. It also plays a driving role in developing and proposing services, such as video conferencing and federated identification.

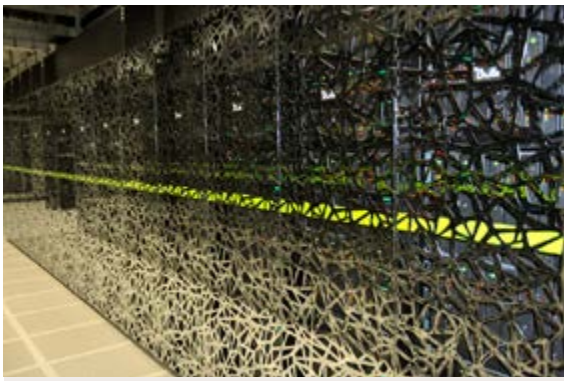
Grid'5000 and FIT are experimental infrastructures for digital science research, which excludes operational services. GRID'5000 is a flexible and large-scale scientific instrument in the fields of parallel and distributed computing, as well as clouds. FIT is an open large-scale testing infrastructure that allows remote access to various computer resources in the context of Internet of Things. FIT users can test performance, interoperability, and security with a very large number of devices. Two infrastructures are currently considered as projects: GERM and RNRVA. GERM includes the four following mathematics hosting centres: CIMPA, CIRM, IHES, and IHP. This project aims to confirm the French position in basic and applied research in mathematics, with the development of structures for hosting researchers and fostering collaborations around the world. RNRVA is a national network dedicated to high-level infrastructures for virtual and augmented reality, managed by AFRV (French Association of Virtual Reality). It is composed of high speed network, special equipment, and dedicated staff in order to tackle scientific challenges according to industrial needs.

LIST OF RESEARCH INFRASTRUCTURES
DIGITAL SCIENCES AND TECHNOLOGIES; MATHEMATICS

TYPE	NAME	FULL NAME	ESFRI
VLRI	GENCI	Grand Équipement National de Calcul Intensif	
VLRI	RENATER	National Telecommunications network for Technology, Education and Research	
RI	CCIN2P3	IN2P3/CNRS Computing Center	
RI	FIT	Future Internet of Things	
RI	France Grilles	France Grilles	
RI	Grid 5000	Grid'5000	
Project	GERM	Grand Équipement pour la Recherche en Mathématiques	
Project	RNRVA	National Network platforms Augmented and Virtual Reality	

GENCI

Grand Équipement National de Calcul Intensif



Type: VLRI, Limited company under French law

Headquarters location:
Paris, FR

Other sites:
Bruyères-le-Châtel, Orsay, Montpellier

Head of the Infrastructure:
Philippe LAVOCAT

Construction:

2007

Stakeholders in France:
MENESR, CEA, CNRS, CPU, Inria

Contact in France:
contact@genci.fr

www.genci.fr

GENCI provides French researchers with the best supercomputers to ensure they achieve outstanding results using numerical simulation. GENCI has 3 main missions:

- to implement the French national strategy for equipping in HPC resources the 3 national computing centers: TGCC at CEA, Idris at CNRS and Cines for the French Universities. As such, GENCI is responsible for elaborating a multi-year investment plan taking into account the evolution of its super-computers operated in the 3 centers;
- to promote numerical simulation and HPC. GENCI leads or participates in various projects for spreading the use of numerical simulation, such as the Equip@meso project and the HPC for SMEs Initiative;
- to participate in the creation of an integrated European HPC ecosystem. GENCI represents France in the European research infrastructure PRACE (Partnership for Advanced Computing in Europe). GENCI is one of the 4 hosting members of PRACE (alongside GCS in Germany, BSC in Spain and Cineca in Italy), which provides European users with world-class systems and high-valued services (training, code enabling, support for SMEs...).

SOCIO-ECONOMIC IMPACT

French industrials can access to GENCI's resources when involved in a project led by an academic institute or for testing HPC on a limited project.

Since 2010, GENCI leads, with Bpifrance and Inria, the HPC for SMEs Initiative for helping SMEs to switch to numerical simulation. This successful program will be amplified in 2016 through the regions, thanks to a public funding.

DATA

Data flow: The data are produced and stored on the computing centers. Users then recover them.

Data storage: 35 PB distributed across 3 computing centers

Accessibility: Via RENATER

Operating costs
—
1.8 M€

Personnel
—
13.55 FTE

International dimension

PRACE ESFRI Landmark

GENCI represents France within PRACE. The European research infrastructure PRACE (Partnership for Advanced Computing in Europe) was created in April 2010 and gathers today 25 country members. Established as an international not-for-profit association under Belgian law (AISBL). With Curie and five other systems, PRACE offers to Europeans users a total of more than 18 Pflop/s, a computing power that is comparable to what the US, China or Japan make available for their academic researchers.

Coordinator: Sanzio Bassini, Council president

Partner countries: 25 countries are members of PRACE: AT, BE, BG, CY, CZ, DK, FI, FR, DE, EL, HU, IE, IT, NL, NO, PL, PT, SK, ES, SE, CH, TR, UK. Only 4 of them (DE, FR, IT, ES) are hosting supercomputers.

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 the ROM and COM "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 does not pose the problems to grouping the different entities of competences to my research and education community.

SOCIO-ECONOMIC IMPACT

All the sectors of innovation that work collaboratively are expected to use RENATER infrastructure.

RENATER also serves as the backbone of RIE (Interdepartmental/ Interministry network of the state) by providing optical links to this network.

Construction costs

—

30 M€

Operating costs: 22 M€

Personnel

—

70 FTE

International dimension

Renater is connected to the pan-European network GEANT by hosting 3 nodes of this network (Paris, Marseille, Geneva).

Coordinator: GEANT Association (Dutch law association) headquarter is based in Amsterdam (NL) and offices are based in Amsterdam (NL) and Cambridge (UK).

Partner countries: 43 NRENs of European countries or having a cooperation agreement with the European program for research and development project. RENATER has also established agreements with African countries for assistance in setting up networks in these countries.

Website: www.geant.net



Type: VLRI

Headquarters location:
Paris, FR

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Patrick DONATH

Construction:

1993

Stakeholders in France:
MENESR, CNRS, CPU, CEA, Inra, CNES, Inria, Inserm, ONERA, Cirad, Irstea, IRD, BRGM

Contact in France:
support@renater.fr

www.renater.fr

CC-IN2P3

IN2P3/CNRS Computing Center



Type: RI

Headquarters location:
Villeurbanne, FR

Head of the Infrastructure:
Pierre-Etienne MACCHI

Construction:
1986

Stakeholders in France:
CNRS

Contact in France:
contact@cc.in2p3.fr

cc.in2p3.fr

CC-IN2P3 has developed a strong expertise in the following domains: computing and data processing, very large data storage, relational databases, networks, system administration, user support, IT management systems. It has a cutting-edge expertise in the grid and cloud computing.

Thus it is one of the 14 international data centers set up in the framework of the worldwide LHC Computing Grid project (W-LCG). It provides 11% of the worldwide resources needed for the processing and analysis of the four LHC experiments data. It is one of the main actors of the LCG-France project and the backbone of the French grid infrastructure.

CC-IN2P3 is very committed into several astroparticles and astrophysics projects. In space astrophysics, CC-IN2P3 is one of the main computing centers for the Planck/HFI, Fermi and AMS missions.

Equally with the NCSA American computing center, it will carry out the data processing produced by the LSST project and will make this telescope whole dataset available to the research community. In the framework of the EUCLID space mission, it will be the main component of the French ground segment and will provide 30% of the resources required to the first data release.

DATA

Data flow: 50 PB per year

Data storage: 18 PB on standard performance disks, 2 PB on high performance disks

Storage used on magnetic tapes: 31 PB out of 340 PB nominal capacity, 1.1 PB of backuped data (nominal capacity of 5.5 PB)

Accessibility: Via RENATER

Operating costs
—
7.1 M€

Personnel
—
78.6 FTE

FIT

Future Internet of Things

The evolution towards an ever more digital world requires tools for testing and experimenting in support of the design and validation of new technologies. These tools can be built around core technologies such as cloud and infrastructure networks but also around the "vertical" domains such as health, transport, and energy, which require data capture technologies to feed their knowledge chains. This is why FIT provides a wide choice of technologies (Internet of Things, Wireless, Overlays, SDN and Cloud) and also a single interface through which to access the system and a large number of configuration and monitoring tools. FIT enables experimentation across a broad range of subject, greatly reduces the cost and time required to design, establish and monitor an experiment, and through testing, the robustness of the solutions is increased.

FIT's mission is to provide a large-scale experimentation environment through the federation of testbeds that are competitive at the worldwide level, allowing to incubate advanced experiments and to stimulate of a large base of users coming from the research world as well as industry.

SOCIO-ECONOMIC IMPACT

The industrials Alcatel-Lucent, Orange, and Thales are members of the FIT Steering Committee.

FIT collaborates with the Institute for Information Industry (III) with the deployment of an IoT-Lab testbed in Taiwan.

FIT has developed a membership model for companies, based on the models of PlanetLab Europe and OneLab.

DATA

Data storage: Setting up of a storage service to allow users saving their generated data.

Accessibility: FIT wishes to put in place an open data policy. However, the data produced by industrial experimenters or presenting a confidential aspect (health, privacy, etc.) will be protected.

Presence in data networks: FIT is part of the OneLab federation.

Construction costs
—
12 M€
Operating costs: 1.5 M€

Personnel
—
11 FTE

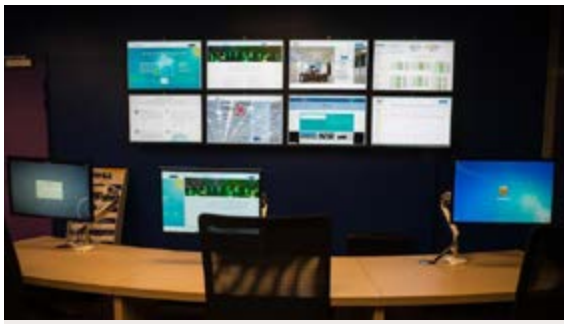
International dimension

Federation OneLab

Coordinator: Serge Fdida

Partner countries: FR, BE, DE, EL

Website: onelab.eu



Type: RI

Headquarters location:
Paris, FR

Other sites:
Évry, Grenoble, Lille, Lyon, Rocquencourt, Sophia-Antipolis, Strasbourg

Head of the Infrastructure:
Serge FDIDA

Construction:	Operation:
2011	2014

Stakeholders in France:
UPMC, CNRS, Inria, IMT, UNISTRA

Contact in France:
serge.fdida@upmc.fr

fit-equipex.fr

FRANCE GRILLES

France Grilles



Type: RI

Headquarters location:
Aubière, FR

Other sites:
Distributed research infrastructure

Head of the Infrastructure:
Vincent BRETON

Construction:

2010

Stakeholders in France:
CEA, CNRS, CPU, Inra, Inria, Inserm, RENATER

Contact in France:
info@france-grilles.fr

www.france-grilles.fr

France Grilles DCI is multidisciplinary and open to all sciences and to developing countries. This DCI is an open space for collaborations within and across disciplines and organizations. Operated by CNRS Institut des Grilles and by Cloud Computing, France Grilles main objectives are as follows:
- establish and operate a national production grid and cloud infrastructure for high throughput data storage and analysis;
- contribute with the other countries involved to the EGI European e-infrastructure;
- strengthen synergies and collaborations between teams doing research on grids and clouds and teams using them using for scientific production.

The infrastructure includes more than 40,000 processors and about 25 Po of distributed storage on twelve sites in France. France Grilles academic cloud federation has eight sites (six in production status) and offers a total capacity of 2,000 cores and 100 To of storage.

SOCIO-ECONOMIC IMPACT

Resources and services are accessible to companies or organizations in the framework of their research projects in collaboration with France Grilles partners.

DATA

Accessibility: Via RENATER

Presence in data networks: French partner of EGI, "Réseau Bases de Données" of CNRS

Operating costs
—
2.5 M€

Personnel
—
7.33 FTE

International dimension

France Grilles is the French National Grid Initiative (NGI) and is the French representative in EGI. EGI is the largest distributed infrastructure in the world, allowing scientific communities to share resources, data and expertise for High Throughput Com

Coordinator: Yannick Legré, Managing Director

Partner countries: BE, BG, CH, CZ, EE, ES, FI, FR, DE, EL, HR, HU, IL, IT, MK, NL, PL, PT, RO, SI, SK, SE, TR, UK

Website: www.egi.eu

GRID'5000

Grid'5000

Grid'5000 is a large-scale and versatile testbed for experiment-driven research in all areas of computer science, with a focus on parallel and distributed computing including Cloud, HPC and Big Data.

Grid'5000 is mainly open to researchers in parallel and distributed computing for experiments at all levels of the software stack. Additionally, due to the hardware available and the high speed connections between sites it has also been found a very useful platform for any scientific community to develop and understand algorithms and applications at scale, testing with specific software stacks or hardware combinations.

Because of its focus on support high quality experiments rather than on raw computing power made available to user, it is a unique and precious scientific instrument for computer science.

Its scale and positioning make it a very unique platform.

SOCIO-ECONOMIC IMPACT

8 startups have been created on the basis of the results: Activeon, Easyvirt, Efficit, Genes Diffusion, Lyatiss/Cloudweaver, Rozzo, Stimergy, Sysfera.

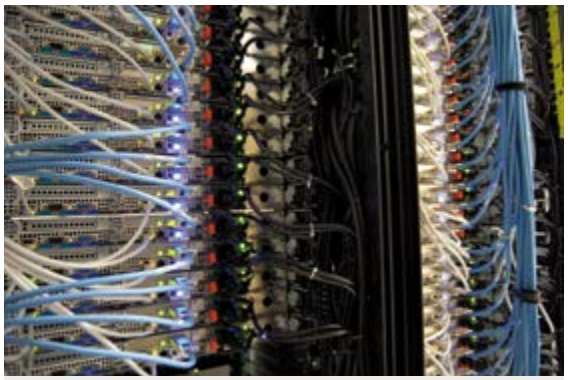
Construction costs

4.8 M€

Operating costs: 0.2 M€
(not including material renewal)

Personnel

6.81 FTE



Type: RI

Headquarters location:
Grenoble, FR

Other sites:
Lille, Luxembourg, Lyon, Nancy, Nantes, Rennes, Sophia-Antipolis

Head of the Infrastructure:
Frédéric DESPREZ

Construction:

2012

Stakeholders in France:
Inria, CNRS, RENATER, CEA, CPU, CDEFI, IMT

Contact in France:
bureau_gis_g5k@inria.fr

www.grid5000.fr

GERM

Grand Équipement pour la Recherche en Mathématiques



Type: Project

Headquarters location:
Paris, FR

Other sites:
Île-de-France, Grenoble, Marseille, Nice

Head of the Infrastructure:
Virginie BONNAILLIE-NOEL

Stakeholders in France:
CNRS, UPMC, UGA, UCA

Contact in France:
virginie.bonnaillie@ens.fr

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

- coordinate international exchange and collaboration centers such as IHP (Henri Poincaré Institute), CIRM (Centre International de Rencontres Mathématiques) and IHES (Institut des Hautes Études Scientifiques) and keep them up international competition level;
- promote mathematics and their interactions in developing countries with the support of the CIMPA (International Center for Pure and Applied Mathematics);
- coordinate interactions between the mathematical community and enterprises and society;
- offer public access to an Audiovisual Mathematics Library, conceived as an elaborate platform built on a body of lectures given by mathematicians from all over the world during their stay in France. It will offer all conveniences of high-level documentary research on a basis of catalogued films enriched with metadata;
- strengthen the coordination between the above institutions to serve as a durable, well-organized device that will offer the international community a complete range of services.

GERM will become the French hub for all those missions.

SOCIO-ECONOMIC IMPACT

GERM will give enterprises, researchers and students visibility as to the opportunities in the domain of interactions with enterprises and will organize Maths Job-Fairs enabling students and recruiters of medium and large size enterprises to meet. It will organize local Maths-Enterprises Study-Weeks, bringing industrials and academic researchers together to explore multidisciplinary topics.

Operating costs

2.2 M€

RNRVA

National Network platforms Augmented and Virtual Reality

During the last decade, virtual reality and augmented reality have moved from a stage of scientific exploration accompanied by a technology development and application of scientific experimentation to the maturity and evaluation purposes. The objective of RNRVA is to be the trigger for the next step: the first large-scale deployment in sciences other than computer and then in various industries. Its mission is to provide a set of hardware, software, and skills especially in the academic sector but also in the world of business.

Networking within the RNRVA through a set of equipment and extremely varied skills, either in multisensory feedback devices, in multimodal interactive devices and more generally in terms of uses will be a great tool for the scientific production and the industrial development for researchers and engineers. RNRVA be likely to strengthen proximity between research laboratories and the industrial ecosystem (especially in the AFRV) to produce a major industrial and scientific impact.

The major scientific challenges that this infrastructure would face are numerous and multidisciplinary by essence. Some of the most important challenges are those of complexity, transparency devices, the naturalness of interaction, and virtual human.

Operating costs
—
7 M€

Personnel
—
5 FTE



Type: Project

Headquarters location:
Bordeaux and Rennes, FR

Other sites:
Distributed research infrastructure

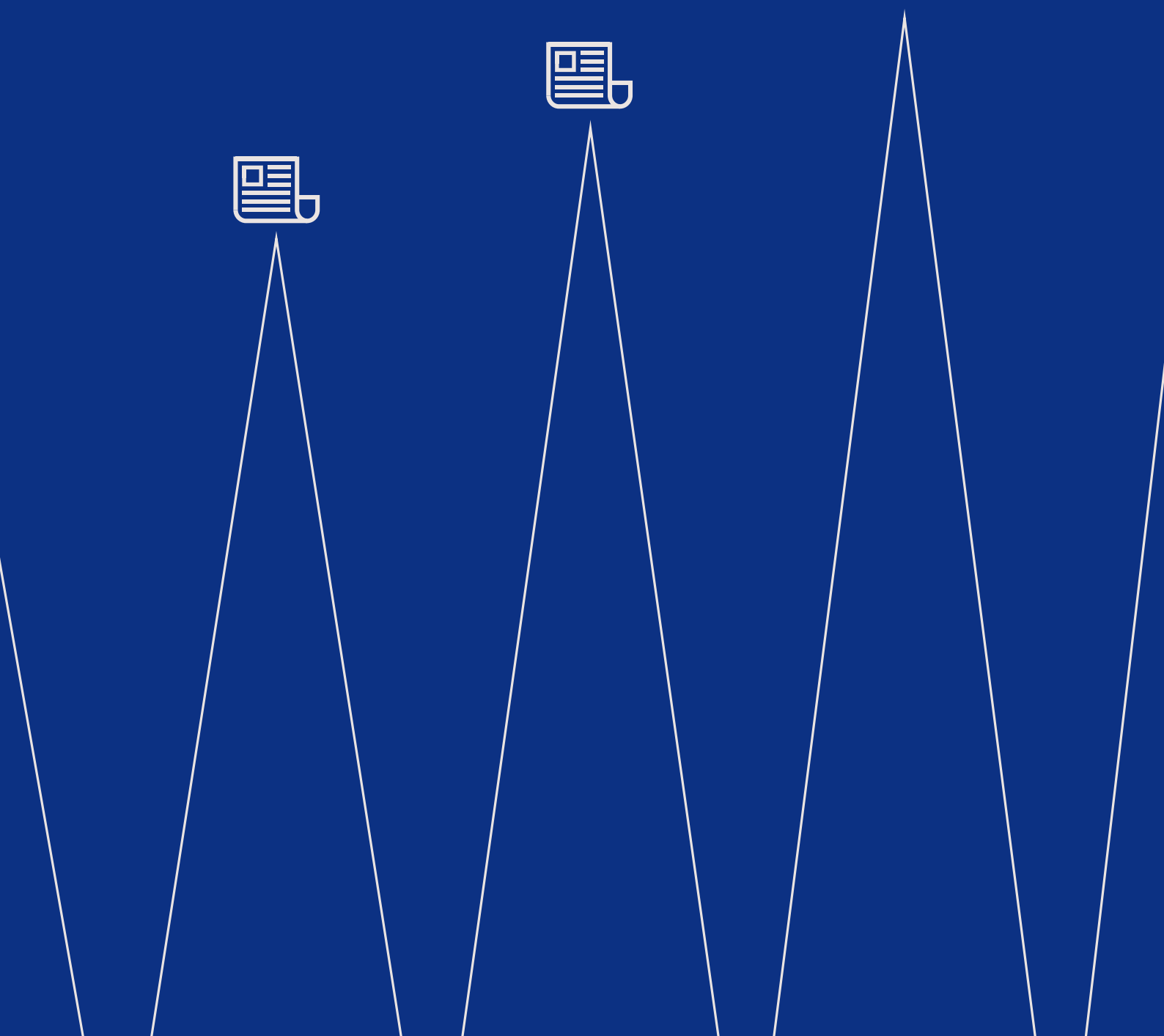
Head of the Infrastructure:
Matthieu LEPINE, Bruno ARNALDI, Pascal GUITTON

Stakeholders in France:
CNRS, Inria, Universities, Higher education schools

Contact in France:
matthieu.lepine@immersion.fr
bruno.arnaldi@irisa.fr
pascal.guitton@labri.fr



SCIENTIFIC AND TECHNICAL INFORMATION



Scientific and technical information

The importance of scientific and technical information (STI) infrastructures increased during the 2000s, due to the accelerated digitization of scientific publications, and the development of international platforms for distributing publications, which have facilitated the creating of scientometric tools with better performance.

In France, STI is now listed as a field in itself provided with infrastructures that are essential for scientific practice, based on its importance in the economy of research systems, with for objectives the structuring of a very active but highly scattered sector, and the development of access to an abundant quality scientific resources offering, while still limiting the costs of it.

1
FROM THE SCIENCE DIGITAL LIBRARY (SDL) TO THE HAL, OPEN-EDITION, COLLEX-PERSEE AND NUMEDIF INFRASTRUCTURES

The national system for coordination and cooperation in STI, named "Digital scientific library" (Bibliothèque scientifique numérique: BSN) was created in 2009 in order to provide researchers with an STI offering with a worldwide level of excellence, and improve the visibility of French research. It covers 9 fields (acquisitions, metadata cataloguing, Open access, digitization, long term archiving, public scientific publishing, document supply, training, research data) and brings together stakeholders (MENESR, organisations, universities, BnF...) and platforms (HAL, PERSEE, OpenEdition, NUMEDIF). The - BSN focussed particularly on the subscription to scientific journals, the acquisition of digital archives (€60 million ISTEX "PIA" programme) and national licences (Elsevier contract...).

The change in structures leads today to identifying, in theBSN, the platforms, expanding, which meet all of the criteria required to be listed as Infrastructures in Scientific and Technical Information, under the supervision of the Alliance Athena in the name of all of the Alliances. The BSN is one of the 4 pillars of the CODORNUM (Steering committee on digital technology in the higher education and research).

2
THE FOUR STI PLATFORMS: HAL, OPEN-EDITION, NUMEDIF AND COLLEX-PERSEE

These four platforms are complementary "usage-technology" sets, that cover the process of disseminating scientific output. They share the -goal to open up French scientific production output internationally while ensuring technological independence. They interact with all of the international infrastructures (shared metadata, partnership agreements, reversion systems).

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

The open archive (hal.archives-ouvertes.fr) offers open access repository of scientific articles and associated data, as well as of theses. Created in 2001 by the CNRS,

DISTRIBUTION PROCESS OF RESEARCH RESULTS



this archive has been adopted by all of the institutions of ESR (higher education and research act). In 2006, research institutions and universities signed a protocol of agreement for a coordinated approach, on a national scale, for the open archiving of scientific output. The HAL platform is connected to many international repository, including ARXIV. Around this platform, the Centre for Direct Scientific Communication (CCSD), in association with the CNRS, INRIA, and the University of Lyon, has created other tools: Sciencesconf.org (seminars), Episciences.org (epijournals), Héloïse (publisher copyright policies).

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

It brings together platforms hosting 420 journals, 1,400 research notebooks, 2,600 books, linked to more than 28,000 scientific programmes. OpenEdition draws together international research communities (50 million annual visits). Its visibility as an infrastructure will increase, on a European level, the impact of the multidisciplinary research projects that it disseminates, and their ability to transfer their results to the socio-economic stakeholders in order to address societal challenges.

It thus entails:

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

2-3 NUMEDIF: multi-channel dissemination and distribution

The NUMEDIF platform is the result of collaboration between the university press distribution department entrusted to FMSH, and a research unit on the publishing activity of the University of Caen. This shared public platform of multi-channel dissemination-distribution is based on the prescription of norms and standards in the field of publishing and digital distribution as well as on the running of a network (training, partnerships, etc.).

It optimises the circulation of scientific writings and their provision in digital form (archives, platforms, etc.) as well as material (dissemination in bookshops and libraries or provision to individuals). Focused on books in SSH, its targets are academic bookshops for current output, university libraries and those of research centres; it is also available internationally (online sales).

Special attention is given to the articulation and interoperability with public operators in STI: OpenEdition (platforms), Hal (open archives), Persée (retro-digitization). NUMEDIF is now compatible with the standards of the platforms Revues.org and Cairn (reviews) and Open Edition Books (books).

2-4 COLLEX-PERSEE: identification and consolidation of major scientific collections available online and in the major libraries

The 4th infrastructure coordinates, in a network that optimises their action, stakeholders that are indispensable but less visible in the research production process as well as in the dissemination of scientific output: libraries. CollEx-PERSEE brings together the reference libraries in their disciplines (BDIC, BNUS, BIU of the Sorbonne, GED Condorcet, BULAC, Health Library, libraries of INHA, of the Paris Observatory, of MNHN...), the BnF, as well as STI operators (ABES, CTLes, INIST), and Huma-Num, aiming to develop new services, articulated with the collections, with a direct link to their users-researchers.

leaning on the PERSEE digitization platform, this infrastructure makes it possible to manage and highlight the major heritage and scientific collections. It is also a major tool for acquisition and sharedpreservation policies, whose logic is both disciplinary and based on territorial strategies.

LIST OF RESEARCH INFRASTRUCTURES SCIENTIFIC AND TECHNICAL INFORMATION

TYPE	NAME	FULL NAME	ESFRI
RI	COLLEX PERSEE	Collections d'excellence pour la Recherche - Persée	
RI	HAL, CCSD	Open archive HAL (Hyper Article en Ligne), Center for direct communication	
RI	NUMEDIF	NUMérique pour l'ÉDItion et la DIFFusion de la production scientifique	
RI	*OpenEdition* [1]	*Open electronic edition in humanities and social sciences*	

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

COLLEX-PERSEE

Collections d'excellence pour la Recherche - Persée

CollEx-PERSEE is a distributed infrastructure that was created to bring together researchers seeking scientific documentary resources and to facilitate their usage. It allows better coordination and mutualised national access to documentary resources that are negociated by (inter)disciplinary communities, as well as to the printed or digital heritage and scientific corpora. It supports the ESR policy concerning helping researchers' access to digitization and shared conservation and participates in the development of digital Humanities in liaison with Huma-Num.

It provides structure for the scientific communities (notably those represented by the Athéna Alliance) and the major documentary actors re-united in GIS (reference university libraries, research organisms, BnF, documentary networks; Persée; State operators: ABES, CTLes). Its mission is to optimize the research environment, by consolidating documentary collections and constituting corpora of research materials that are unique and attractive in the international field. To this end, their referencing is optimized along with their use by researchers and research groups. It designs and provides a services offer targeted as closely as possible to the needs of research (collecting material for research projects, indexing, web referencing and mapping of the collections of excellence. It provides accessibility and remote supplies, services designed with the researchers).

PERSEE is the central operator, both for organizing the digitization programs with the researchers and as a platform for dissemination and access.

SOCIO-ECONOMIC IMPACT

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

Construction costs

0.115 M€
Operating costs: 8.5 M€

Personnel

Coordination: 0.5 FTE.
Other personnel of CollEx distributed in the organisations partners of the infrastructure.



Type: RI

Headquarters location:
Paris, Lyon, FR

Other sites:
Aix, Bordeaux, Bussy-Saint-Georges, Caen, Grenoble, Lille, Lyon, Montpellier, Nancy, Poitiers, Strasbourg, Toulouse

Head of the Infrastructure:
Michel MARIAN, Françoise THIBAULT, Nathalie FARGIER

Construction:	Operation:
2014	2014

Stakeholders in France:
MENESR, Alliance Athéna, Univ. Lyon, CNRS, ENS Lyon

Contact in France:
collex@recherche.gouv.fr

www.collex.eu

HAL

Open archive HAL (Hyper Article en Ligne), Center for direct communication



Type: RI

Headquarters location:
Villeurbanne, FR

Head of the Infrastructure:
Christine BERTHAUD

Construction:	Operation:
2000	2001

Stakeholders in France:
CNRS, Inria, Univ. Lyon

Contact in France:
direction@ccsd.cnrs.fr

hal.archives-ouvertes.fr

HAL is a multidisciplinary open archive platform used by all members of higher education and research organisations. HAL is connected to the main international servers ArXiv, PubMed Central, RePEC, OpenAIRE.

HAL serves the purpose of communicating open access documents produced by research (pre-print or post-print journal article, conference papers, books...) on 380 disciplines in 13 major scientific fields. Its strategy is part of the international movement of open access and H2020 project. Submissions are subject to quality data moderation, i.e. technical compliance of file formats, file and metadata coherence, publisher's policies and verification of the scientific level of the document. It is the common and shared platform for the entire French ESR as part of an inter-institution agreement (2013).

HAL provides to institutions who want to create an institutional open archive all the tools and features to implement this project (portal). HAL also provides technical solutions to local AO platform. HAL achieves the long-term data preservation with CINES. All referentials used in HAL are accessible in an open access website. HAL develops tools with similar large international projects.

DATA

Presence in data networks: OpenAire, DARIAH-EU, PubMedCentral

Construction costs
—
0.15 M€
Operating costs: 0.09 M€

Personnel
—
14 FTE, i.e. 8 72 k€

International dimension

ArXiv, French miroir site managed by CCSD

Coordinator: Cornell university, USA

Website: arxiv.org

NUMEDIF

NUMEDIF (NUMérique pour l'ÉDItion et la DIFFusion de la production scientifique)

The NUMEDIF infrastructure serves the editorial activity of all public research and higher education organisations (CNRS, Universities). It focuses on the development and the dissemination of a standard ecosystem for the digital production of interoperable scientific contents and the building of a specific device for dissemination and distribution.

It aims at ensuring the scientific literature is disseminated and made available in the best conditions both in a computer-readable form (archives, platforms...) and in paper versions (books, journals, bookshops, libraries...) and improving the visibility of the French public scientific edition on an international level.

It enables the supply national platforms (Open Edition, Cairn...) for a very low cost.

The infrastructure ensures the conservation of data. Archiving is made possible for the Centre informatique National de l'Enseignement supérieur (CINES) thanks to the use of Unicode and the documented standardization of structures (XML-TEI).

Its mission and services are:
- building of collections of edited, standardized, interoperable contents based on the single source publishing model;
- articulating the necessary distribution scales (bookshops and specialized audience, broad dissemination, online dissemination, dissemination of transferable digital forms, fee-based dissemination, open access – including OpenEdition);
- providing information monitoring and training.

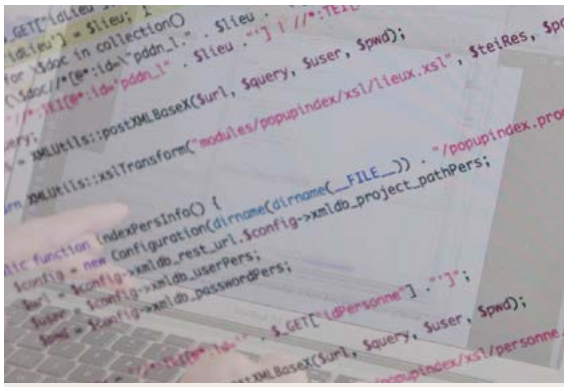
SOCIO-ECONOMIC IMPACT

The software industry, the development of the environment of standardized structured flows, the development of robots for the composition of standardized structured flows for e-advertisement production and the supply of dissemination platforms.

Distributors and broadcasters, development of TEI/ONIX mixed flows for the referencing and optimization of multi-support dissemination to supply print-on-demand channels.

Construction costs

0.92 M€
Operating costs: 0.75 M€



Type: RI

Headquarters location:
Paris, FR

Other sites:
Caen

Head of the Infrastructure:
Pascal BULEON

Construction:	Operation:
2015	2015

Stakeholders in France:
FMSH, MRSH, CNRS, UniCaen

Contact in France:
numedif@msh-paris.fr

OPENEDITION

Open electronic edition in humanities and social sciences



Type: RI

Headquarters location:
Marseille, FR

Other sites:
Paris

Head of the Infrastructure:
Marin DACOS

Construction:	Operation:
2007	2007

Stakeholders in France:
AMU, BSN, CNRS, DARIAH, EHESS, Univ. Avignon

Contact in France:
contact@openedition.org

www.openedition.org

OpenEdition is a comprehensive infrastructure for electronic publishing in the humanities and social sciences, created and operated by the UMS Cleo. It brings together complementary platforms dedicated to journals (Revues.org), books series (OpenEdition Books), research blogs (Hypotheses) and academic announcements (Calenda). In 2015, OpenEdition received more than 3 million visitors 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 specialist platforms (Revues.org, OpenEdition Books, Calenda, Hypothèses), 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.

SOCIO-ECONOMIC IMPACT

With funding from the PIA (French program "Investing for the Future"), partnership in text mining and automatic text-enhancemen projects: Demain un autre jour (DUAJ) et Qwam Content intelligence (QUAM CI).

www.demainunautrejour.com
www.qwamci.com

DATA

Data flow: data traffic: 130 TB/year

Data storage: 6 TB

Presence in data networks: Indexed in following reference databases: OpenAIRE, OAPEN, DOAB (Directory of Open Access Books), DOAJ (Directory of Open Access Journals), Base (Bielefeld Academic Search Engine), EZB (Elektronische Zeitschriftenbibliothek), Google Scholar, Journal TOCs, Mir@bel, New Jour, Sudoc, Isidore (Huma-Num), WorldCat (OCLC)

And in libraries databases: AtoZ (EBSCO), 360 Core (Serials Solutions), SFX (Exlibris), LinkSolver (Ovid), EBSCO Discovery Service, Summon (Proquest), Primo Central (Exlibris)

Construction costs

4 M€
Operating costs: 3 M€

Personnel

45 FTE

International dimension

under construction, OPERAS project.

Coordinator: Pierre Mounier, EHESS, FR

Partner countries: DE, IT, CA, PT, NL, EL, UK

Website: operas.hypotheses.org

ANNEXES

Annex 1

THE NATIONAL STRATEGY 2016 UPDATE PROCESS

The previous editions of the national research infrastructure strategy were published in 2008 and 2012. This 2016 update is the result of a largely renewed collective process in which the research alliances and organisms have played a central role with the constant support of DGRI.

The launching day was held on July 7, 2014 to define the framework: the articulation with the update of the ESFRI roadmap, the establishment of Coordination Groups (GC) gathering members from the 5 thematic Alliances, the research organisms and the ministry's departments as well as a Project Team gathering DGRI representatives and the GC chairmen.

In each scientific domain, the potential candidate infrastructures were identified by the GC, then asked during the spring 2015 to fill a detailed questionnaire. A description sheet was extracted from each of these questionnaires and validated by the research organisms in charge of the facility. Finally, a thematic synthesis, corresponding to those of this document, was prepared by the GC for each scientific domain. These sheets and syntheses were then presented to the High Council of the Very Large Research Infrastructures (HC-TGIR) in July 2015. This independent body which is composed of 13 renowned experts from all scientific fields, with an extensive experience in management of major infrastructure and major research projects, analyzed the RI landscape and all the descriptions. Its report was finalized in October 2015.

Based on this analysis, the Steering Committee of the Very Large Research Infrastructures (CD-TGIR) fixed the comprehensive list of facilities officially registered for France. This body, chaired by the director of the DGRI and composed of the presidents of Alliances, the CEO of CNRS and the General Administrator of CEA endorsed the French landscape, including the officially recognized projects.

Finally, the presentation of this landscape is the subject of this document as well as of a completely redesigned website, and in which developments can be followed over time.

The publication of these documents was officially unveiled at a special event of presentation on March 24, 2016 at the MENESR associated to another special event devoted to the economic model of the Research Infrastructures which took place on March 25, 2016.

Annex 2

RESEARCH INFRASTRUCTURES 2016: IO, VLRI, RI, PROJECTS

TYPE	NAME	FULL NAME	ESFRI
SOCIAL SCIENCES AND HUMANITIES			
TGIR	Huma-Num	Large facility for digital humanities	DARIAH (2006)
TGIR	Progedo	Data Production and Management	ESS (2006) CESSDA (2006) SHARE (2006) GGP (2016)
IR	*OpenEdition* [1]	*Open electronic edition in Humanities and Social Sciences*	
IR	RnMSH	Social Sciences and Humanities Centers Network	
Project	*ERIHS-FR* [2]	*European Research Infrastructure for Heritage Science*	*ERIHS (2016)*
EARTH SYSTEM AND ENVIRONMENTAL SCIENCES			
IO	CEPMMT	European Centre for Medium-Range Weather Forecasts	
TGIR	Concordia	French – Italian Antarctic Station	
TGIR	ECORD/IODP	European Consortium for Ocean Drilling Research / International Ocean Discovery Program	
TGIR	EURO-ARGO	European contribution to Argo programme	EURO-ARGO (2006)
TGIR	FOF	The French Oceanographic Fleet	
TGIR	ICOS	Integrated Carbon Observation System	ICOS (2006)
IR	ACTRIS - FR	Aerosol, Cloud and Trace Gases Research Infrastructure - France	ACTRIS (2016)
IR	ANAEE - FR	Analyses and Experimentation on Ecosystems – France	ANAEE (2010)
IR	ClimERI-FR	National Infrastructure for Earth System Climate Modelling-France	
IR	ECOSCOPE	Observations and Datasets Center for Research on Biodiversity	

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

TYPE	NAME	FULL NAME	ESFRI
IR	ECOTRONS	Ecotrons	ANAEE (2010)
IR	*EMBRC-FR*[3]	*National Marine Biological Resource Center*	*EMBRC (2008)*
IR	*EMPHASIS France*[4]	*European Multi-environment Plant pHenomics And Simulation InfraStructure -France*	*EMPHASIS (2016)*
IR	EMSO - France	European Multidisciplinary Seafloor and water column Observatory - France	EMSO (2006)
IR	IAGOS - France	In-service Aircraft for Global Observing System	IAGOS (2006)
IR	I-LI-CO	Seashore And Coastal Research Infrastructure	
IR	OZCAR	Critical Zone Observatory, Research and Applications	
IR	RARE	Agronomic Resources for Research	
IR	RECOLNAT	French Naturalist Collections Network	
IR	RESIF/EPOS	French seismic and geodetic network /European Plate Observing System	EPOS (2008)
IR	SAFIRE	French Airborne Environment Research Service	
Project	*IBISBA-FR*[5]	*Industrial Biotechnology Innovation and Synthetic Biology Accelerator*	
Project	Pôle de données	Data and Services Center for Earth System Modelling	
ENERGY			
IR	FR-SOLARIS	Solar Thermal Research Infrastructure for Concentrated Solar Power	EU-SOLARIS (2010)
IR	WEST	W(Tungsten) Environment for Steady-state Tokamaks	
Project	ECCSEL-FR	European Carbon Dioxide Capture and StoragE Laboratory Infrastructure	ECCSEL (2008)
Project	SOPHIRA	SOlar PHotovoltaic Research Infrastructure	
Project	Theorem	Testing facilities for Hydrodynamics and Marine Renewable Energy	Marinerg-i (2016)
BIOLOGY AND HEALTH			
IO	EMBL	European Molecular Biology Laboratory	
IO	EMBC	European Molecular Biology Conference	
IR	BIOBANQUES	Biobanks national infrastructure	BBMRI (2006) + MIRRI (2010)
IR	CELPHEDIA/ PHENOMIN	French national infrastructure in mouse phenogenomics	INFRAFONTIER (2006)
IR	CELPHEDIA/ TEFOR	Transgenesis for functional studies in model organisms	

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

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

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

TYPE	NAME	FULL NAME	ESFRI
IR	CONSTANCES	Population-based epidemiological cohorte	
IR	CRB Anim	Biological Resource Centers for domestic animals	
IR	E-CellFrance	French Network Infrastructure for mesenchymal stem cell (MSC)-based therapies	
IR	*EMBRC-France*[6]	*National Marine Biological Resource Center*	*EMBRC (2008)*
IR	*EMPHASIS France*[7]	*European Multi-environment Plant pHenomics And Simulation InfraStructure*	
IR	FBI	France-BioImaging	EUBIO (2008)
IR	F-CRIN	French Clinical Research Infrastructure Network	ECRIN (2006)
IR	FLI	France Life Imaging	EUBIO (2008)
IR	France Génomique	French national genomics and bioinformatics infrastructure	
IR	Fr-Hadron	France HADRON	
IR	FRISBI	French Infrastructure for Integrated Structural Biology	INSTRUCT (2006)
IR	HIDDEN	Highly Infectious Diseases Dedicated Infrastructure ExtensioN	ERHINA (2008)
IR	IDMIT	Infectious Deseases Models for Innovative Therapies	
IR	IFB	French Institute of Bioinformatics	ELIXIR (2006)
IR	INGESTEM	National Infrastructure for pluripotent stem cells and tissue engineering	
IR	MétaboHub	The French national infrastructure for metabolomics and fluxomics	
IR	NEURATRIS	Translational research infrastructure for innovative therapies in Neuroscience	EATRIS (2006)
IR	PGT	Pre Industrial Geno Therapy Consortium	
IR	PROFI	Proteomics French Infrastructure	
Project	*IBISBA-FR*[8]	*Industrial Biotechnology Innovation and Synthetic Biology Accelerator*	
MATERIAL SCIENCES AND ENGINEERING			
TGIR	ESRF	European Synchrotron Radiation Facility	ESRF Upgrade Ph 1 (2006) ESRF Upgrade Ph 2 (2016)
TGIR	ESS	European Spallation Source	ESS (2006)

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

7 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".

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

TYPE	NAME	FULL NAME	ESFRI
TGIR	ILL	Institut Max von Laue - Paul Langevin	ILL Upgrade Ph 1 (2006)
TGIR	Orphée/LLB	ORPHEE/Laboratoire Léon Brillouin	
TGIR	Soleil	French national synchrotron facility	
TGIR	XFEL	European X-ray Free Electron Laser	XFEL (2006)
IR	EMIR	Federation of the accelerators for the studies of materials under irradiation	
IR	FT-ICR	Very high field FT-ICR mass spectrometer national network	
IR	LNCMI	The National High Magnetic Field Laboratory	EMFL (2008)
IR	LULI-APOLLON	Laboratory for the Use of Intense Lasers	
IR	METSA	Transmission Electron Microscopy and Atom Probe	
IR	PETAL	PETAwatt Aquitaine Laser	
IR	RMN	Magnetic Nuclear Resonance, Very High Fields	
IR	Renard	Research Infrastructure Interdisciplinary EPR National Network	
IR	RENATECH	French national nanofabrication network	
Project	*ERIHS-FR*[9]	*European Research Infrastructure for Heritage Science*	*ERIHS (2016)*
ASTRONOMY AND ASTROPHYSICS			
IO	ESO	European Southern Observatory	
	ESO ALMA	Atacama Large Millimeter/Submillimiter Array	
	ESO EELT	European Extremely Large Telescope	E-ELT (2006)
	ESO LSP	La Silla & Paranal Observatory	
TGIR	CFHT	Canada-France-Hawaii Telescope	
TGIR	IRAM	Institute for Radio Astronomy at Millimeter wavelength	
IR	CDS	Strasbourg Astronomical Data Centre	
IR	ESO-INSTRUM	Instrumentation for ESO large telescopes	
IR	*HESS*[10]	*High Energy Stereoscopic System*	
IR	ILT-LOFAR FR	International Low Frequency Radio Array Telescope - LOFAR FR	
Project	*CTA*[11]	*Cherenkov Telescope Array*	*CTA (2008)*

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

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

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

TYPE	NAME	FULL NAME	ESFRI
NUCLEAR AND HIGH-ENERGY PHYSICS			
IO	CERN-LHC	European Organization for Nuclear Research - Large Hadron Collider	
TGIR	EGO-VIRGO	European Gravitational Observatory - VIRGO	
TGIR	FAIR	Facility for Antiproton and Ion Research	FAIR (2006)
TGIR	GANIL-Spiral2	Grand National Heavy Ion Accelerator (GANIL), Radioactive Ion Production System in Line of 2nd generation (SPIRAL2)	Spiral2 (2006)
IR	*HESS*[12]	*High Energy Stereoscopic System*	
IR	KM3NeT	Kilometre Cube Neutrino Telescope	KM3NET (2006, 2016)
IR	LSST	Large Synoptic Survey Telescope	
Project	*CTA*[13]	*Cherenkov Telescope Array*	*CTA (2008)*
DIGITAL SCIENCES AND TECHNOLOGIES; MATHEMATICS			
TGIR	GENCI	Grand Équipement National de Calcul Intensif	
TGIR	RENATER	National Telecommunications network for Technology, Education and Research	
IR	CCIN2P3	IN2P3/CNRS Computing Center	
IR	FIT	Future Internet of Things	
IR	France Grilles	France Grilles	
IR	Grid 5000	Grid'5000	
Project	GERM	Grand Équipement pour la Recherche en Mathématiques	
Project	RNRVA	National Network platforms Augmented and Virtual Reality	
SCIENTIFIC AND TECHNICAL INFROMATION			
IR	COLLEX PERSEE	Collections d'excellence pour la Recherche - Persée	
IR	HAL, CCSD	Open archive HAL (Hyper Article en Ligne), Center for direct communication	
IR	NUMEDIF	NUMérique pour l'ÉDItion et la DIFFusion de la production scientifique	
IR	*OpenEdition*[14]	*Open electronic edition in Humanities and Social Sciences*	

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

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

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

PHOTO CREDITS

COVER

K. Pierre/IPEV; Gabriel OLALDE/CNRS image library; © C2RMF/A. Maigret-V. Fournier; MRSH-communication-2015; © Pascal Morillon/Université de Rennes 1; © Cyril FRESILLON/CNRS image library; Philippe Stroppa; Gemini-CFHT ; © Julien Fuchs/LULI.

SOCIAL SCIENCES AND HUMANITIES

Cover page Fotolia
ERIHS © C2RMF/A. Maigret-V. Fournier
HUMANUM Stéphane Pouyllau, CNRS, 2015
PROGEDO © PROGEDO
RNMSH © National network MSH - 2014

EARTH SYSTEM AND ENVIRONMENTAL SCIENCES

Cover page Guillaume Petriat
ACTRIS Thibaut VERGOZ/OSU Réunion/CNRS image library
AnaEE Copyright Quentin Benard
CEPMMT ECMWF
Concordia K. Pierre/IPEV
CLIMERI © Animea, F. Durillon pour le LSCE/CEA/IPSL
Constances INSERM/Patrice Latron
ECORD ACEX1_M-Jakobsson et ACEX2_M-Jakobsson: M. Jakobsson © ECORD/IODP
ECOSCOPE CNRS image library - Yann Fontana, Dominique Gibert, Emmanuel Perrin; INRA image library - Frédérique Bressoud, Rémi Le Bastard; Rights reserved
ECOTRONS Architecture workshop Téqui/J. Roy
EMPHASIS Claude Welcker © INRA Montpellier
EMSO © EMSO
Euro-Argo. ERIC Euro-Argo
FOF UMS The french oceanographic fleet
I-LI-CO Ifremer, CNRS, SHOM, UBO
IAGOS T. Laurent
ICOS Les Défis du CEA/F. Mathé
OZCAR Jerome Gaillardet © IPGP
Pôle de données ESA/ATG Medialab et MétéoFrance
RARe INRA
RECOLNAT e-ReColNat-MNHN
RESIF-EPOS CNRS
SAFIRE SAFIRE, Jean-Christophe Canonici

ENERGY

Cover page © Fotolia
ECCSEL BRGM/BLCom
FR-Solaris Gilles Flamant
SOPHIRA M. Joanny – CEA.
THEOREM M. Nicolas JOB
WEST CEA-IRFM- Christophe Roux

BIOLOGY AND HEALTH

Cover page © CNRS/Denis Morel
Biobanques istock
Celphedia-Phenomin © INSERM
Celphedia-Tefor TEFOR Core Facility
Constances INSERM/Patrice Latron
CRB-ANIM INRA
E-CELL C. Jorgensen © U1183 Inserm
ECOSCOPE CNRS image library - Yann Fontana, Dominique Gibert, Emmanuel Perrin; INRA image library - Frédérique Bressoud, Rémi Le Bastard; Rights reserved
EMBC EMBC
EMBL EMBL_Lignes_Lumiere_Octobre_2015_Pierre Jayet_2-2
EMBRC © W. Thomas
F-CRIN © F-CRIN 2016
FBI © Julien Burger - Institut Jacques Monod
FLI FLI
Fr-Hadron JC Blouzard holder
FRISBI IGBMC
France-Génomique © Francis Rhodes
HIDDEN Inserm/Delapierre, Patrick
IBISBA © LISBP
IDMIT Tourret-Jonery Architects
IFB JFGibrat
INGESTEM © Inserm U935/ESTeam Paris Sud, O. Féraud.
METABOHUB L. Lizet
NEURATRIS @NeurATRIS/CEA
PGT-2 Platform GenoSafe © Christophe Hargoues
PROFI INSERM/Patrice Latron

MATERIAL SCIENCES AND ENGINEERING

Cover page © Jérémy BARANDE/Permission to use granted by Newport Corporation
EMIR @ Serge Bouffard
ILL ILL_R.Cubitt
LLB P. Stroppa/CEA
LNCMI © Julien Billette – LNCMI © Denis Morel – image library CNRS
PETAL CEA
RENARD credits IM2NP
RMN © CNRS
FT-ICR Edith Nicol
LULI-2 © Julien Fuchs/LULI
METSA © Pascal Didier/CNRS/IPCMS
SOLEIL Synchrotron SOLEIL - CAVOK Production/Laurent PERSIN
RENATECH © Cyril FRESILLON/CNRS image library
XFEL (xfel.riken.jp/eng/index.html) © X-ray Free Electron Laser
ESRF 2 ESRF/P. Ginter
ESS European Spallation Source

ASTRONOMY AND ASTROPHYSICS

Cover page © Clem & Adri Bacri-Normier/ESO
CDS © 2010 UDS/CNRS by CDS - Distributed under CNU CPL V.3
CFHT Jean-Charles Cuillandre (CEA-Saclay - Paris observatory- CFHT)
ESO ALMA A. Marinkovic/X-Cam/ALMA (ESO/NAOJ/NRAO)
CTA © G. Pérez, IAC (SMM)
ESO – EELT ESO/L. Calçada
ESO – INSTRU ESO
ESO – LSP J.L. Dauvergne & G. Hüdepohl (atacamaphoto.com)/ESO
ESO – OI ESO-OI
HESS Christian99 - personnal work, CC BY-SA 3.0
ILT Copyright belongs to ASTRON (NL)
IRAM © IRAM

NUCLEAR AND HIGH-ENERGY PHYSICS

Cover page © CERN
CERN CERN
EGO-VIRGO C. Fresillon/VIRGO/CNRS image library
FAIR ion42 for FAIR/GSI Helmholtzzentrum für Schwerionenforschung
GANIL GANIL
Km3NET KM3NeT Collaboration
LSST Large Synoptic Survey Telescope (LSST)

DIGITAL SCIENCES AND TECHNOLOGIES; MATHEMATICS

Cover page Cyril FRESILLON/CNRS image library
CCP-IN2P3 © A.Melliez/CC-IN2P3 (CNRS)
FIT UPMC
France-Grilles © France Grilles - Silvia Gervois
GENCI © Cines
GERM © GERM
GRID-5000 © Pascal Morillon/University of Rennes 1
RENATER RENATER
RNRVA © Bruno Arnaldi

SCIENTIFIC AND TECHNICAL INFROMATION

Cover page © SCY/CC.O/Pixabay
COLLEX Jean-Pierre Rosenkranz for University library Strasbourg; UMS Persée
HAL © CCSD
NUMEDIF MRSH-communication-2015
OpenEdition Lisa George (Cléo). Licence CCBY

Publication date: March 2016
Concept and graphic realization: Opixido

Ministry of Education,
Higher Education and Research
1, rue Descartes
75231 Paris cedex 05