RESEARCH INFRASTRUCTURES

FOR FRANCE

Roadmap 2008

INTRODUCTION

European research infrastructures are facilities for the benefit of all scientific disciplines. They are extremely diverse in nature and essential to the advancement of knowledge for modern science. But research infrastructures are also sources of innovation and development, benefiting to Europe's economy and competitiveness.

This roadmap for the research infrastructures for France is the result of an important work done by the ministry of higher education and research. Its goal is the establishment of a survey of the large infrastructures, already existing or in project, and the assessment that they fit into our strategy for the development of France's national system for research and innovation. This contribution is essential for ensuring the most efficient articulation between France's projects and those of the European Research Area.

These infrastructures, at the forefront of knowledge, are also flagships that shed light on scientific and technologic research, contributing to the attraction of young people to science and to the emergence of scientific vocations.

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FOR RESEARCH INFRASTRUCTURES

Preamble

Excellence is essential for scientific research. Hence, a major challenge, in the coming years, is to bring France's universities and research centres at the best level in the world.

To achieve this objective, French researchers must have access to high-quality research infrastructures, whether they are located in France or abroad. Indeed, because of high complexity and cost, national level infrastructures must also be part of a global network of research infrastructures.

The French roadmap 2008 for research infrastructures (RIs) presents a strategic vision for ensuring access to the best world-class infrastructures. It describes:

- existing RIs or RIs for which the implementation has already been decided,
- RIs at a planning stage. Although they are not yet decided, the ministry for higher education and research would like to see them available to researchers over the next 15 to 20 years.

The purpose of the roadmap is to help funding bodies (government, local authorities, research organisations, universities...) for deciding their future investments in infrastructures. This roadmap has been drawn up in line with the recent recommendations of the *Haut Conseil de la Science et de la Technologie (HCST)* [French committee advising France's President and government] on very large research infrastructures[1]. However, this first edition of the roadmap does not include space and defence areas.

It is in line with the roadmap published in 2006 (updated in 2008) by the European Strategy Forum on Research Infrastructures (ESFRI)[2]. Among the 90 infrastructures identified in this document, 36 are also included in the 2008 ESFRI roadmap, which shows the large overlap of national and European priorities as regard to research infrastructures.

The roadmap has been drawn up from contributions issued from thematic working groups, made up of leading players of the relevant research fields, which took into account the needs of the scientific community, the quality of scientific production, the openness to higher education and, if necessary, the importance of expected industry partnerships.

Such a roadmap is of course not a frozen list. Its content will be periodically reviewed and updated, just as it is at the European level by ESFRI. The work underpinning the preparation of

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[1] Haut Conseil de la Science et de la Technologie, *Avis sur les très grandes infrastructures de recherche*, 20 December 2007 (http://www.hcst.fr)

[2] ESFRI: European roadmap for research infrastructures – Report 2006 (http://cordis.europa.eu/esfri/). The list comprises 35 projects.

the roadmap can be found on the website: *http://www.roadmaptgi.fr*., as well as future subsequent updatings when available.

The systematic identification of RIs shed light on the importance of the budget issue. It is difficult to imagine that the pressing needs for new facilities will be satisfied only through a significant increase in the ministry of higher education and research's budget. Therefore, the construction of new infrastructures can thus also mean the end of operations for existing RIs, because their contributions to research are no longer significant, or their operating costs became too high.

RIs are important not only because they account for a significant part of the government's budget for research, but also because they contribute for a large part to the French scientific production.

It is expected that the opening of RIs to new scientific communities (especially in the sciences for environment, life, humanities and society) will lead to a significant improvement in the responses to the major questions that the country is facing today: pushing the boundaries of knowledge, while simultaneously improving the understanding of the mankind environment.

1. Background

The concept of Research Infrastructures has evolved over time and covers today a broad range of facilities and resources.

For a long time, the definition was restricted to large telescopes, or to physics single-site instruments. Today, responding to the growing demand from other scientific disciplines (life sciences, information and communication science and technology, humanities and social sciences, etc.), smaller scale infrastructure networks (clinical research centres, nanotechnology platforms, imaging facilities, etc.) are also considered as RIs. The same is true for wholly distributed networks, such as computing grids or distributed databanks.

RIs are also diverse in nature and usages. Using the typology proposed by the HCST[3], three main functions of RIs can be defined according to their purpose:

- **Programme** RIs, related to national or international programmes (nuclear energy, space research, biology, etc.),
- **Service** RIs used by different scientific and technological communities, and eventually by industry. They ensure continuing, reliable services at the highest technological level (sources of light and neutrons, digital libraries, scientific vessel fleets, micro- and nano-manufacturing platforms, etc.),
- **Mission-oriented** RIs that are needed to push the knowledge boundaries (the CERN LHC[4] particle collider or the neutrino detectors are typical examples).

It should be stressed that there are no RIs that do not include a major specific research activity of the highest level as part of their core activity.

[3] Cf. *ibid.* p.I

[4] LHC: *Large Hadron Collider*

The size of RIs is also often related to the importance of their user communities. Several situations can be distinguished:

- In particle physics as well as in earth and universe sciences, the communities are coordinated on a global scale and the required instruments have such a high cost that financing must be shared between all actors. Hence, these are referred to as ***global projects***. They are usually built and operated by international organisations. It is the case for example of the LHC (CERN), ALMA (ESO) or ITER.
- Other infrastructures are of a ***pan-European dimension***, and can be in competition with equivalent infrastructures in the United States or Japan, as for example ESRF, ILL or ECMWF. They are managed by ad hoc organisations, the members of which belong to Member States of the European Union or associate countries.
- Finally, there are research infrastructures of a ***national dimension*** (such as synchrotron SOLEIL), which obey to national governance, with nonetheless international cooperations. They are managed by an ad-hoc structure (SOLEIL) or one or more research organisations (LLB).

It must finally be pointed out that the cost of RIs varies considerably depending on their size and field of research. Hence, the forecast total investment over the life of the CERN LHC, which is a global project, amounts to €4 billion euros and its annual operating costs amount to 620 million euros, whereas operating an infrastructure in the humanities and social science can be of as little as 1 million euros per year.

Therefore, to take into account evolutions in the notion of RIs, the following definition has been adopted in the framework of the present roadmap:

A Research Infrastructure is a facility developed to conduct major targeted research and to provide successfully a service for one or more large scientific communities. Its cost of construction and operation is such that it justifies a concerted decision-making process at national level, and possibly at a European or international level, with a multi-annual programming. Its governance is centralised and the assessment of its missions and activities is performed by high-level scientific committees. Access to the facility is open to all on the basis of scientific excellence.

2. RIs to meet the challenges of French research

The major challenges of French research, for which RIs constitute a structuring factor of the activities, are given below. They concern both extending the boundaries of knowledge of the universe and understanding the impact of man on his environment. They also contribute to the improvement of man's living conditions on earth as well as our understanding of man himself.

2-1. The planet

Knowledge of the Earth is of prime importance both for understanding the physical, chemical and biological processes that govern the environment in which we live, and for identifying the mechanisms by which we alter this environment. Numerous questions do not find answers by simple observations or scientific conjectures. They require measurements and models. Either for meteorology, climatology, ocean dynamics, behaviour of tectonic plates or the Earth's mantle, biodiversity and ecosystems, scientific research requires the use of large centralised or distributed instruments that allow to access this information: oceanographic ships or observatories, sensor networks (geophysics), deep-bore instruments, high altitude aircrafts, high performance computers, distributed information systems, etc.
In some cases, the coordination of infrastructure programmes is undertaken by inter-organisation committees (CDO[5] for monitoring the oceans, CIO-E[6] pour for monitoring the environment, CSTF[7] for naval resources).

2-2. The universe as seen from Earth

Observation of the universe calls upon all instruments that enable knowledge to be forged on the extra-terrestrial universe, on the scales of its ultimate limits of space and time. It involves astronomy, astrophysics including astroparticles. The instruments concerned are optical and radio telescopes, large interferometers, but also customised communication and computing instruments. One of the aims of the observations is to understand the origin of the universe: the description of the Big Bang remains one of the major objectives of astrophysics for the 21st century. The question of the possible existence of life forms in the universe is also open, but the dynamics of solar atmosphere, as well as the behaviour of the planets inside the solar system, remain major subjects of research.

2-3. Subatomic particles, nuclei and energy

Surprisingly, the smaller the size of the object under investigation is, the larger the infrastructures are. All superlatives are possible when talking about elementary particles, the sizes of which are smaller than what can be easily conceived and about instruments such as CERN-LHC (elementary particle accelerator placed in an underground ring of 27 km circumference with detectors in regard of which the human size is hardly discernible). The study of nuclei, clusters of elementary particles, is essential for the knowledge of their structure and the interactions that govern them. This quest for understanding the ultimate nature of the

[5] Committee of the research organisations directors for the ocean and climate research programme (IFREMER, IPEV, CNRS-INSU, IRD, CNES, SHOM, Météo-France).
[6] Committee of research organisations on the environment.
[7] Strategic and technical committee for the marine fleet.

matter of our universe justifies the technological feats. This also benefits to the economy more than we might think, with examples such as the internet or mass-market electronic components. However, we are continuously approaching the limits of what man can conceive and build. This explains why we are now also turning towards the study of astroparticles coming from space. Just as with the observation of the universe, these fields also contribute to our understanding of the laws that are at the origin of the universe and that govern our evolution.

The field of research on nuclei is also tied up with the field of energy research. Energy production is a major challenge for our society, due to the increased needs and to the close correlation between a country's energy consumption and economic activity. To this are added the issues of national independence and sovereignty, but also the environmental constraints faced by today's world.

In the specific field of nuclear energy, it is also important for France to maintain its industrial leadership and its research effort on the various pathways for the future exploitation of these energy sources (4^{th} generation fission reactors and nuclear fusion).

In parallel to these, it is also necessary to maintain high-level research activities in related fields, such as material irradiation and waste processing (by means of transmutation, for example). This research requires specific RIs such as experimental reactors.

2-4. Matter

The study of matter in all its states -- gas, liquid, crystallised or amorphous solids, thin layer solids, plasma and isolated molecules -- often requires advanced characterisation techniques. The challenges have implications in terms of technology (microprocessors, nanostructures) and knowledge required for materials science (to develop future electronics components or new energy technologies) or for life sciences (to understand the processes in biological structures and to develop tomorrow's medicines).

This need for high-performance facilities leads to a pooling of instruments that would be too expensive for a single laboratory (technological platforms, networks coordinated to serve a whole community). This pooling may concern just one very large instrument with which the users perform their experiments either by travelling there or remotely, as is the case of synchrotron radiation sources, neutron generators or intense magnetic fields.

2-5. Information, communication, computing and data services

The field of information and communication technologies keeps evolving, thanks to progress made in parallel by optical and electronic technologies. However, the most visible progress concerns the uses of these developments and the central role of software everywhere.

There are various uses, but today's main areas of development are computing grids and data storage, high-performance scientific computing, very high-performance communication networks and scientific data management. All these features are necessary for the support of what is now known as **e-science** programmes. In particular, they allow for a new approach of the way scientific research activities are performed in relation with research infrastructures. Virtualisation, data sharing and remote access, all things which are made possible today by very high-performance communication networks, facilitate the wide circulation of data.

These data infrastructures are the precursors of tomorrow's information and knowledge society. The extraordinary development of Internet, since the end of the 90s, has radically altered individuals' lifestyles and how companies operate. Progress in mobile telephony, convergence of telecommunications and audiovisual technologies, integration of nanotechnologies or virtualisation of services are just some of the factors of change in our society. RIs are needed for the development of the science of information and communication technology serving a society that is increasingly dependent on the circulation and pooling of information.

2-6. Social sciences and humanities

Research infrastructures in the field of social sciences and humanities (SSH) are closely linked to the development of technologies for information and communication (ICT). Even if libraries were formerly the main facilities for this field, it is no longer the case today due to the emergence of resources and services made possible by wide circulation and management of data.

Digital libraries, archives and repositories, bibliographic databases and sociological surveys with online access, all these instruments are extremely diverse, from the most traditional up to the most experimental ones, such as EPI[8] or blog-journals. More fragile than what preceded them, this digital data and documents require a long term permanent access and a set of formats that both take into account scientific work itself and technical evolutions. The resulting instruments contribute, in return, at transforming the practice of researchers.

Consequently, beyond the renewal of the question of accessing scientific documents (sources and published papers), SSH research infrastructures allow for the constitution and use of highly-varied corpuses likely to open up new avenues of research both epistemological and disciplinary. Within the scope of a largely open social area, all these instruments contribute moreover to a better valorisation of our scientific and cultural assets.

2-7. Life sciences and health

The rapid progress of techniques for life science research -- molecular structure, genomics, bio-informatics, various imaging techniques, animal and vegetable models and their experimental facilities, collections of biological material, translational and clinical research, and observations and experiments with regard to the environment -- have given rise to significant research infrastructures at the disposal of life-science researcher communities.

These infrastructures are naturally distributed and provide services based on knowledge. The emergence of large life-science infrastructures establishes a new culture and a new way of distributing tasks and responsibilities within this community. Efforts have therefore been made, both at a national and European level, to link these infrastructures in a network, with the aim of sharing know-how and achieving critical mass, improving the quality and efficiency of services, and developing training for young researchers. *GIS IBiSA* [scientific grouping around biology, health and agronomy platform projects] was established to rationalise the funding of an ensemble of life-science infrastructures. The present roadmap is also an opportunity to identify emerging needs not covered by existing facilities, like the case of translational research.

[8] EPI stands for interactive publication

3. The roadmap: existing and already decided RIs and others at the planning stage

The 90 Research Infrastructures which are included in the roadmap fall into three categories:

- **Existing** RIs: this category comprises the 46 running infrastructures, at the date of the publication of the roadmap,
- **Decided** RIs: 19 infrastructures not yet operational, but their financing is expected. They can also include distributed facilities in the process of refining their coordination (*i.e.* the essential elements exist and an adequate governance structure remains to be established).
- RIs **at the planning stage**: infrastructures the design of which is at an advanced stage, but financing in not assured yet, and long-term projects subjected to the removal of technological bottle-necks, or the design of which is at the draft stage.

The lists by category are given below.

3-1. Existing RIs

Existing Research Infrastructures				
RI	**Description**	**Organisms**	**ESFRI**	**URL**
The Earth				
Marine fleet	Marine fleet for Oceanographic Research	CNRS-INSU, IRD, IFREMER, IPEV, SHOM (coordination CSTF)		http://www.ifremer.fr/flotte/index.php
GODAE / MERCATOR	Operational Oceanography (data and numerical simulation)	GIP (CNRS-INSU, IRD, IFREMER, SHOM, Météo-France)		www.mercator-ocean.fr
EURO-ARGO	Global Ocean Monitoring Infrastructure	CNRS-INSU, IFREMER	* EURO-ARGO	http://www.euro-argo.eu
SAFIRE	Atmospheric Aircraft Fleet for Environment Research	CNRS-INSU, CNES, Météo-France		www.safire.fr

ECMWF	European Center for Mid-Range Weather Forecast	International organisation		www.ecmwf.int
CONCORDIA	International Station on the Antarctic Continent	IPEV (French-Italian collaboration)		www.institut-polaire.fr/ipev/infrastructures_et_moyens/station_concordia_dome_c
ECORD / IODP	European Consortium for Ocean Research Drilling / Integrated Ocean Drilling Program (international)	CNRS-INSU (EU-US-JP Collaboration)		www.ecord.org www.iodp.org
EGS-Soultz	European experimental Site for Geothermy	GEIE		www.soultz.net
RESIF	French sismologic network	GIS (CNRS-INSU)		http://www.insu.cnrs.fr/co/node/169
ECOTRONS	Ecosystem platforms	CNRS		www.cnrs.fr/edd/recherche/infrastructures-ecotrons.htm

Universe as seen from earth

VLT/I (ESO)	Very Large Telescope	ESO		www.eso.org/projects/vlt/
CFHT	Canada-France-Hawaii observatory	CNRS, CNRC, University of Hawaii		www.cfht.hawaii.edu/
HESS/HESS II	High Energy Stereoscopic System	CNRS-IN2P3 International Collaboration		www.mpi-hd.mpg.de/hfm/HESS/HESS.html
IRAM	Millimetric Radioastronomy Institute	CNRS-INSU French-German collaboration		www.iram.fr
ALMA	Large Scale Radio Astronomy facility in Chile	ESO and International Collaboration		www.alma.nrao.edu
LOFAR	LOw Freq ARray (Netherlands, Germany, France and UK)	CNRS-INSU, Paris Observatory		www.lofar.org
CDS	Stellar Data Center in Strasbourg	CNRS-INSU Strasbourg University		http://cdsweb.u-strasbg.fr/CDS-f.gml

Particles, nuclei

CERN, LHC, détecteurs	European organisation for Nuclear Research – Large Hadron Collider	International organisation		www.cern.ch
VIRGO / EGO	Gravitational waves interferometer	CNRS-IN2P3 French-Italian collaboration		www.ego-gw.it
ANTARES	Underwater observatory for high-energy neutrinos	CNRS-IN2P3 and CEA		http://antares.in2p3.fr
GANIL	Grand National Accelerator for Heavy Ions	GIE (CNRS-IN2P3 and CEA)		www.ganil.fr
JET	Joint Experimental Tokamak in UK	CEA (EFDA)		www.jet.efda.org
TORE SUPRA	Supraconducting-coil Tokamak in Cadarache	CEA		www-fusion-magnetique.cea.fr/cea/ts/ts.htm

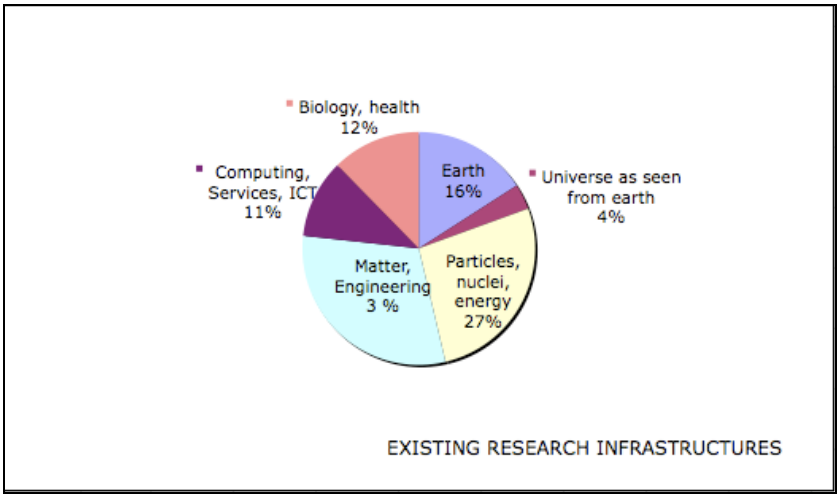
Matter and Engineering

ESRF	European Synchrotron Radiation Facility in Grenoble	Civil society (CNRS and CEA + international partners)		www.esrf.eu
SOLEIL	Synchrotron source in Saclay	Civil society (CNRS and CEA)		wwwsynchrotron-soleil.fr
LULI	Laboratory for the Use of Intense lasers	CNRS, CEA, Ecole Polyt. and Univ Paris VI		www.luli.polytechnique.fr
LIL	Laser Integration Line (Bordeaux)	CEA-DAM		http://petal.aquitaine.fr/spip.php?article35
LLB	Leon Brillouin laboratory for neutron scatering	CEA et CNRS		http://www-llb.cea.fr
ILL	European neutron source / Laue-Langevin Institute in Grenoble	Civil society (CNRS and CEA + international partners)		www.ill.eu
LCMI	High Magnetic Field Laboratory in Grenoble	CNRS		http://ghmfl.grenoble.cnrs.fr

LNCMP	Pulsed Magnetic Field National Laboratory in Toulouse	CNRS		www.lncmp.org
Centrales nanos	Nanotechnology platforms	CNRS, CEA, Universities		http://www.nanomicro.recherche.gouv.fr/
High field NMR	Network of high-field NMR facilities	CNRS, CEA, Universities		http://tgermn.cnrs-orleans.fr
Wind tunnels	Wind tunnels for space and aeronautics	ONERA, CEPR		www.onera.fr
Computing, services, ICT				
GENCI	National Grand Equipment for High Performance Computing	Civil Society (MESR, CEA, CNRS, Univ.)		www.genci.fr
CINES	Computing Center of Higher Education in Montpellier	MESR and Universities		www.cines.fr
IDRIS	Institute for the Development of Scientific Computing Resources	CNRS		www.idris.fr
CCRT	Computing Center for Research and Technology at CEA	CEA		http://www-ccrt.cea.fr
CC-IN2P3	IN2P3 Computing Center	CNRS and CEA		http://cc.in2p3.fr/rubrique221.html
RENATER	National Research and Education Network	GIP (MESR, MEN, CNRS, CEA, CNES, INRIA, INSERM, INRA, IRD, CEMAGREF, BRGM, CPU)		www.renater.fr
Biology, Health				
INSTRUCT	Structural Biology Centers / *Grenoble and Strasbourg*	CEA, CNRS, INSERM, universities	* Instruct	www.ibs.fr www.igbmc.fr
IEHS - P4	High Security Laboratory	INSERM		www.cervi-lyon.inserm.fr

CRB	Biological Resources Centers – Biobanks	INSERM, InCA, Ministry of Health., IFREMER INRA, CIRAD, MNHN, CNRS, Universities	* BBMRI EMBRC	www.inserm.fr/fr/inserm/infrastructures/crb www.biobanks.eu
NeuroSpin	High-field MRI for brain studies	CEA	* EATRIS	http://www-dsv.cea.fr/neurospin
EMBL	European Laboratory for Molecular Biology	International organisation		www.embl.de
IdG (CNS-CNG)	Genomic Institutes for Life Sciences / EVRY	CEA		www.genoscope.cns.fr www.cng.fr

Existing RIs account for 600 M€ for the 2007 budget (operating costs, including salaries and equipment renewal, but not the depreciation value). These costs breakdown as follows:



3-2. Decided RIs

This list includes RIs in the process of construction (current or future), as well as entities distributed in the process of coordination (*i.e.* the essential elements exist and an adequate governance structure remains to be implemented).

	RI	DESCRIPTION	Organism	ESFRI	Web site
Future Research Infrastructures					
Decided Research Infrastructures					
Particles, Nuclei, Energy	**JHR**	Jules Horowitz Reactor - *Cadarache*	CEA (and international partners)	* JHR	http://www-cadarache.cea.fr/fr/entreprises/projets/rjh/
Particles, Nuclei, Energy	**ITER**	International Thermonuclear Experimental Reactor	International organisation		www.iter.org
Particles, Nuclei, Energy	**IFMIF/EVEDA**	International Fusion Materials Irradiation Facility / Engineering Validation Engineering Design Activities	International organisation	* IFMIF	www.frascati.enea.it/ifmif
Particles, Nuclei, Energy	**SPIRAL 2**	System for in-line Production of Radioactive Ions	GIE GANIL (CNRS and CEA)	* SPIRAL2	www.ganil.fr
Particles, Nuclei, Energy	**FAIR**	Facility for Antiproton and Ion Research	German company with international partners (CNRS and CEA)	* FAIR	www.gsi.de/fair/index_e.html
Matter	**XFEL**	X-ray Free Electron Laser - participation	German company with international partners (CNRS and CEA)	* XFEL	www.xfel.eu
Matter	**ILE**	Extreme Light Institute	CNRS, CEA, ENSTA, Ecole polytechnique	* ELI	www.extreme-light-infrastructure.eu
Matter	**PETAL**	PETawatt Aquitaine Laser	CEA-DAM	* HIPER	http://petal.aquitaine.fr/
Matter	**Upgrade ILL**	Millenium - phase 1	Civil society (CNRS and CEA + international partners)	* ILL 20/20	www.ill.eu

Matter	**ESRF upgrade 1**	Upgrade of the European Synchrotron Radiation Facility: phase 1	Civil society (CNRS and CEA + international partners)	* ESFR-Upgrade	www.esrf.eu
Computing, Services, ICT	**National Grid Infrastructure**	National initiative for establishing a production Grid Infrastructure	Governance still to be defined (CNRS, INRIA, CEA, Univ., RENATER, MESR)		www.idgrilles.fr
SSH	**ADONIS**	Research infrastructure to support SSH activities at CNRS	Governance still to be defined (CNRS)	* DARIAH	www.tge-adonis.fr
SSH	**PROGEDO**	Data management for Humanities and Social Sciences	Governance still to be defined (EHESS, CNRS, INED, INSEE, etc.)	* CESSDA ESSurvey SHARE	http://www.centre.quetelet.cnrs.fr
SSH	**CORPUS**	Digital repositories for SSH	Governance still to be defined (EHESS, CNRS, Universities, Ministry of Culture and Communication)	* CLARIN	http://www.cnrtl.fr/ http://www.msh-reseau.fr/spip.php?article34
SSH	**BSN**	Scientific digital libraries	Governance still to be defined (CNRS, SDBU, Univ. Lyon, ENS LSH, EHESS)		http://cleo.cnrs.fr/; www.persee.fr http://www.tge-adonis.fr/
Biology, Health	**CELPHEDIA**	Creation, Breeding, Phenotyping, Distribution and Archiving (mouses, primates, fishes)	Governance still to be defined (CNRS, INRA, INSERM,CEA, Pasteur, Universities)	* Infrafrontier	http://www-mci.u-strasbg.fr, http://transgenose.cnrs-orleans.fr
Biology, Health	**RIEHS - A3**	Network of High Security facilities	Governance still to be defined by GIS IBISA (INRA, CIRAD, CEA, INSERM, Vet. Schools, Pasteur, AFSA)		http://www.ibisa.net/
Biology, Health	**PREDECOB**	Large-scale biomedical cohorts coordination	Governance still to be defined (INSERM, …)		www.inserm.fr/fr/inserm/infrastructures/cohortes/
Biology, Health	**CIC**	Network of Centres for Clinical research	Governance still to be defined (INSERM, Ministry of Health)	* ECRIN	www.ecrin.org

3-3. Selection of RIs at the planning stage

They are 27 in number, which fall into two categories: high-priority and priority projects.

The fact of a RI being included in the roadmap does not guarantee its funding, since foreseeable budgets probably do not allow for the financing of all projects. The final decisions will therefore be taken as part of future budget decisions that take into account additional criteria such as economic consequences, potential impact on industrial innovation and development, as recommended by the *Haut Conseil de la Science et de la Technologie*.

High priority Ressearch Infrastructures

Earth	**Regional ship**	New general-purpose regional ship (Mediterranean or Atlantic).	INSU, IFREMER (Coordination CSTF)		http://www.ifremer.fr/flotte/index.php
Earth	**ICOS**	Integrated Carbon Observation System	Preparatory Phase (ESFRI); CEA, IFREMER, Univ. CNRS-INSU,	* ICOS	http://icos-infrastructure.ipsl.jussieu.fr
Earth	**SOERE**	Environment observatories	CIO-E or ANR		www.anaee.com
Universe as seen from Earth	**E-ELT**	Extremely Large Telescope (42 m)	ESO	* E-ELT	www.eso.org/public/astronomy/projects/e-elt.html
Universe as seen from Earth	**CTA**	Cerenkov Telescope Array	International collaboration (roadmap ESFRI 2)	* CTA	www.cta-observatory.org
Matter	**ESRF upgrade 2**	Upgrade of the European Synchrotron Radiation Facility: phase 2	Civil Society (CNRS and CEA + international partners.)	* ESFR-Upgrade	www.esrf.eu
Matter	**ILL upgrade 2**	Phase 2 of the ILL upgrade	Civil Society (CNRS and CEA + international partners.)	* ILL 20/20	www.ill.eu
Matter	**Magnetism**	High Magnetic Fields for ESRF and ILL *in Grenoble*	CNRS		*http://www.esrf.eu/AboutUs/Upgrade*
Computing Services, ICT	**GRID Infrastructure for Research**	Computer science research for Grids	CNRS, INRIA, Inst. Telecom, Univiversities		www.grid5000.fr
Computing ,Services, ICT	**PRACE**	Partnership for Advanced Computing in Europe	GENCI (CEA, CNRS, MESR and Univ.)	* EU-HPC	www.prace-project.eu
Biology, Health	**LIFEWATCH**	Biodiversity data research infrastructure	MNHN	* Lifewatch	www.lifewatch.eu

Priority Research Infrastructures

Earth	**IAGOS-ERI**	In-service aircraft for a global observing system	Preparatory Phase (ESFRI) CNRS-INSU, Météo-France	* IAGOS-ERI	www.fz-juelich.de/icg/icg-2/iagos
Earth	**COPAL**	Community heavy-payload long endurance instrumented aircraft	Preparatory Phase (ESFRI) CNRS-INSU, CNES, Météo-France	* EUFAR	www.eufar.net
Earth	**EMSO**	European Multidisciplinary Seafloor Observation	Preparatory Phase (ESFRI) IFREMER, CNRS-INSU	* EMSO	www.ifremer.fr/esonet/emso
Universe as seen from Earth	**LSST**	Large Synoptic Survey Telescope (Chile)	CNRS-INSU		www.lsst.org
Universe as seen from Earth	**SKA**	Square Kilometer Array	Preparatory Phase (ESFRI) CNRS-INSU	* SKA	www.skatelescope.org
Universe as seen from Earth	**Km3Net**	Underwater Observatory of High Energy Neutrinos	Preparatory Phase (ESFRI) CNRS-IN2P3, CEA	* Km3Net	www.km3net.org
Particles, Nuclei, Energy	**Super LHC**	Upgrade of LHC.	CERN international organisation		http://public.web.cern.ch/Public/en/LHC/LHC-en.html
Particles, Nuclei, Energy	**ILC ou CLIC**	Global effort for a Linear Collider	CERN International Organisation		www.linearcollider.org
Particles, Nuclei, Energy	**ULISSE/LSM**	Enlargement of the Underground Laboratory of Modane	CNRS-IN2P3, CEA		http://www-lsm.in2p3.fr/
Particles, Nuclei, Energy	**Eurisol**	Particle Accelerator	European collaboration		www.ganil.fr/eurisol
Particles, Nuclei, Energy	**MYRRHA**	Research reactor (Belgique)	European collaboration		www.sckcen.be/myrrha/
Particles, Nuclei, Energy	**IFMIF**	International Fusion Materials Irradiation Facility	International organisation	* IFMIF	www.frascati.enea.it/ifmif/
Matter	**ELI**	Extreme Light Infrastructure	CNRS	* ELI	www.extreme-light-infrastructure.eu
Matter	**ESS**	European Spallation Source	Preparatory Phase (ESFRI) European Collaboration	* ESS-Neutrons	http://neutron.neutron-eu.net/n_ess

Matter	**EMFL**	Network of European High Magnetic Field Laboratories	CNRS (roadmap ESFRI-2)	* EMFL	http://www.emfl.eu
Biology, Health	**Translational Research Center**	Translational Research Center	Preparatory Phase (ESFRI) INSERM, CNRS, CEA, hospitals	* EATRIS	www.eatris.eu

4. Conclusions

The work on the roadmap for research infrastructures has allowed clarifications in several aspects:

- The inventory of research infrastructures was conducted using the views of the whole scientific community, relying on a full "bottom-up" process
- This inventory gives a useful overall view, including a synthesis of budgetary information for existing RIs, providing a global vision to policy makers.
- The scientific community had also the opportunity to propose the construction of new infrastructures, either in France or through participations in European or global projects.
- Among the proposals for new infrastructures, a large majority corresponds to projects in the ESFRI roadmap. This confirms the importance of international cooperation for the French scientific community, while highlighting the growing links between national and European research policies.
- Conversely, most of the ESFRI projects present an interest for one or more national scientific communities. This shows the broad range of research in our country.
- The identification of French priorities for the establishment of new RIs will also contribute to the ESFRI process, by furthering co-investments between Member States having the same priorities.
- The realization of the importance of RIs for all scientific fields, and the new associated dynamic, in phase with the action of the European Commission, strengthens the cooperation between EU Member States and significantly contributes to the integration of new EU countries.

ANNEX 1: Methodology

Criteria used for the selection of RIs in the roadmap.

The diversity in the nature and operating fields of RIs precludes the application of a finite and limited number of criteria, which could be all relevent. Nonetheless, the groups of experts have agreed to use a common set of assessment criteria.

1 Scientific criteria

- Response to the needs of the scientific community
- Quality of expected scientific production

2 Education criteria

- PhD and post-PhD students access
- Higher education access

3 Knowledge transfer criteria

- Importance of expected industrial partnerships
- Importance of expected patent applications

4 Economic criteria

- Importance of expected job and business creation
- Importance of subsequent benefits for local businesses.

ANNEX 2 : GLOSSARY

ANR :	Agence Nationale de la Recherche
BRGM :	Bureau de Recherches Géologiques et Minières
CEA :	Commissariat à l'Energie Atomique
CEMAGREF :	Centre d'Etudes du Machinisme Agricole et des Eaux et Forêts
CERN :	Organisation Européenne de Recherche Nucléaire
CIO-E :	Comité Inter Organismes pour l'Environnement
CNES :	Centre National d'Etudes Spatiales
CNRS :	Centre National de la Recherche Scientifique
ESA :	European Space Agency
ESO :	European Southern Observatory
GENCI :	Grand Equipement National de Calcul Intensif
IFREMER :	Institut Français de Recherche pour l'Exploitation de la Mer
IN2P3 :	Institut National de Physique Nucléaire et de Physique des Particules
INRA :	Institut National de Recherche Agronomique
INRIA :	Insititut National de Recherche en Informatique et Automatique
INSERM :	Institut National de la Santé et de la Recherche Médicale
INSU :	Institut National des Sciences de l'Univers
IPEV :	Institut Paul Emile Victor
IRD :	Institut de Recherche pour le Développement
IRFU :	Institut de Recherche sur les lois Fondamentales de l'Univers
ITER :	International Thermonuclear Experimental Reactor
LLB :	Laboratoire Léon Brillouin

MNHN :	Muséum National d'Histoire Naturelle
RENATER :	Réseau National de télécommunications pour la Technologie, l'Enseignement et la Recherche
SHOM :	Service Hydrographique de la Marine